UM0527
User manual

UPS evaluation board

Introduction

The UPS evaluation board provides a complete solution addressing the low/medium range UPS segment with 700 VA output power capability. The evaluation board, from a hardware and firmware point of view, is ready to support the development of a complete solution. Thanks to the PC software it's possible to monitor all the relevant system parameters using the RS232 interface or the USB. The evaluation board is available for the 120 Vac market and 230 Vac market.

The UPS evaluation board is built in offline topology with AVR regulation of the mains boost and buck. The inverter module contains the push-pull DC/DC converter and the DC/AC output full-bridge generating quasi-sine waveform.

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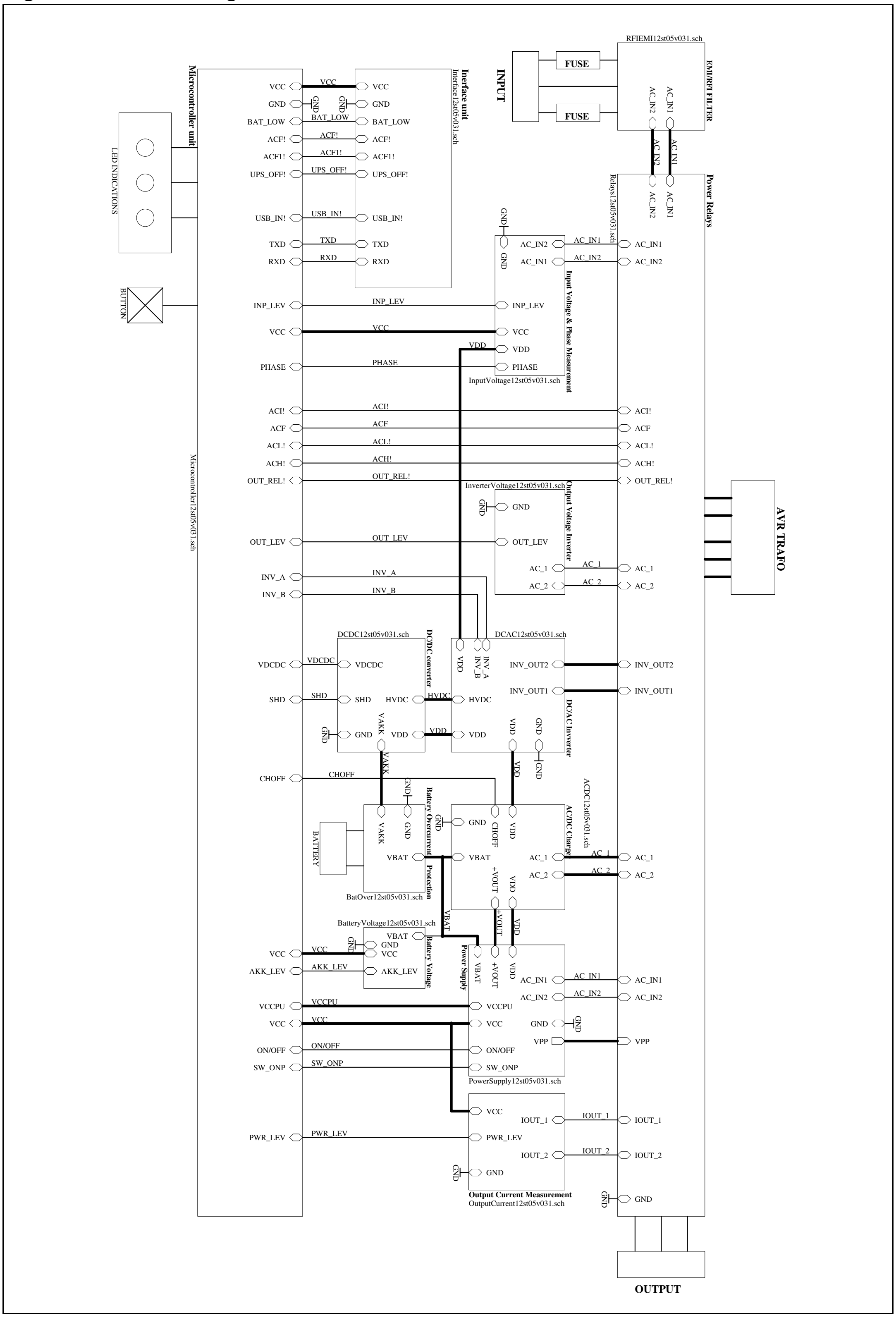
1.1.1 General realization

The UPS evaluation board is built in offline topology with AVR regulation of the mains boost and buck. The inverter module contains the push-pull DC/DC converter and the DC/AC output full-bridge generating quasi-sine waveform. The battery charger module is connected at the output of the UPS and it also has the function of taking over the reactive power which is present on the inverter during battery operation with reactive - resistive load.

The microcontroller controls all UPS functions. It monitors the mains parameters in order to ensure the proper level of the output voltage. The microcontroller measurement parameters are input/output mains voltage and phase, output inverter voltage, battery voltage, output current and output power. The UPS has a built-in RS232, joint signals and USB interfaces (USB for RS232 converter).

1.1.2 Block diagram

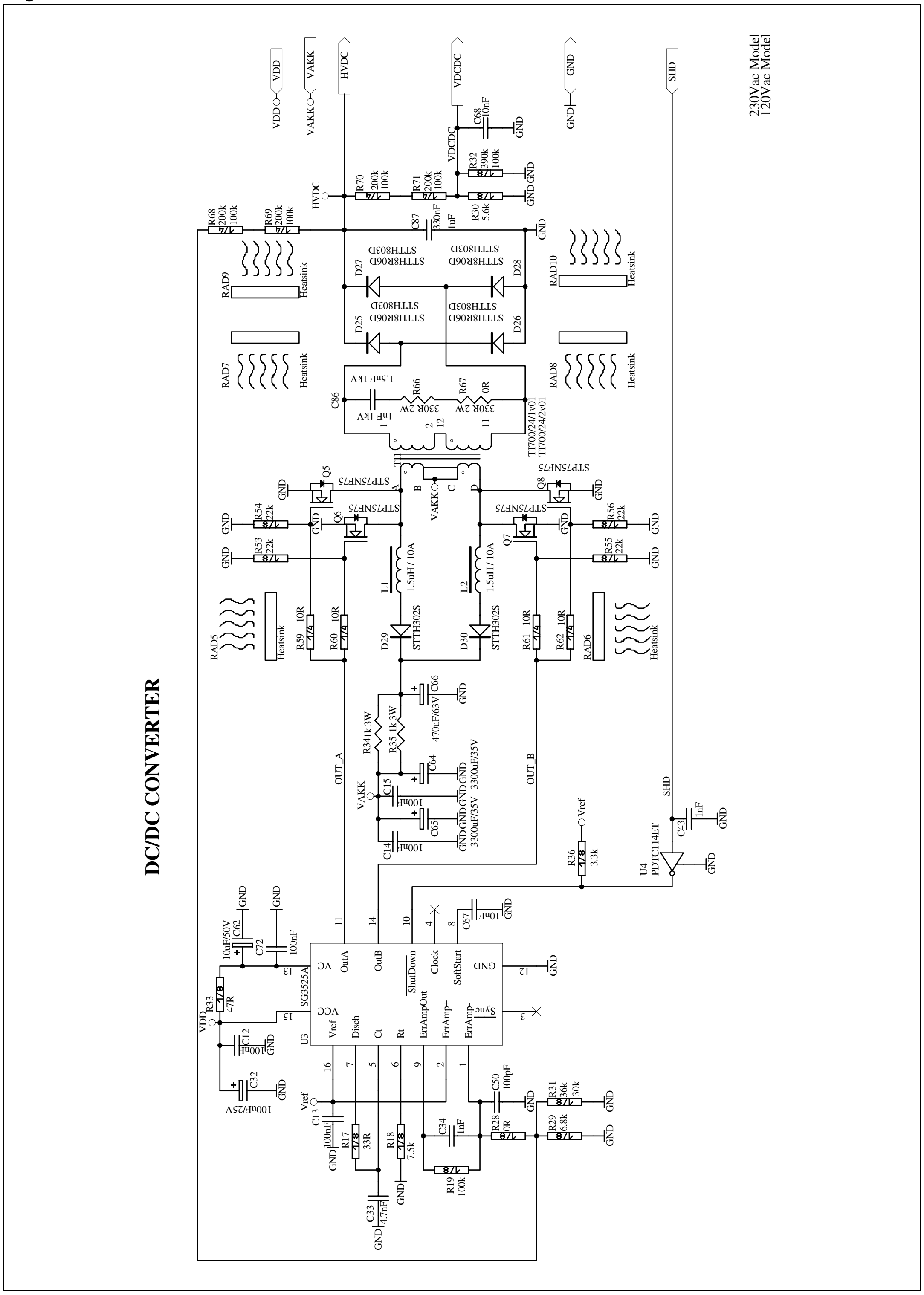
Figure 1. Block diagram



1.1.3 Detailed description of electronics

1.1.4 DC/DC converter module

Figure 2. DC/DC converter



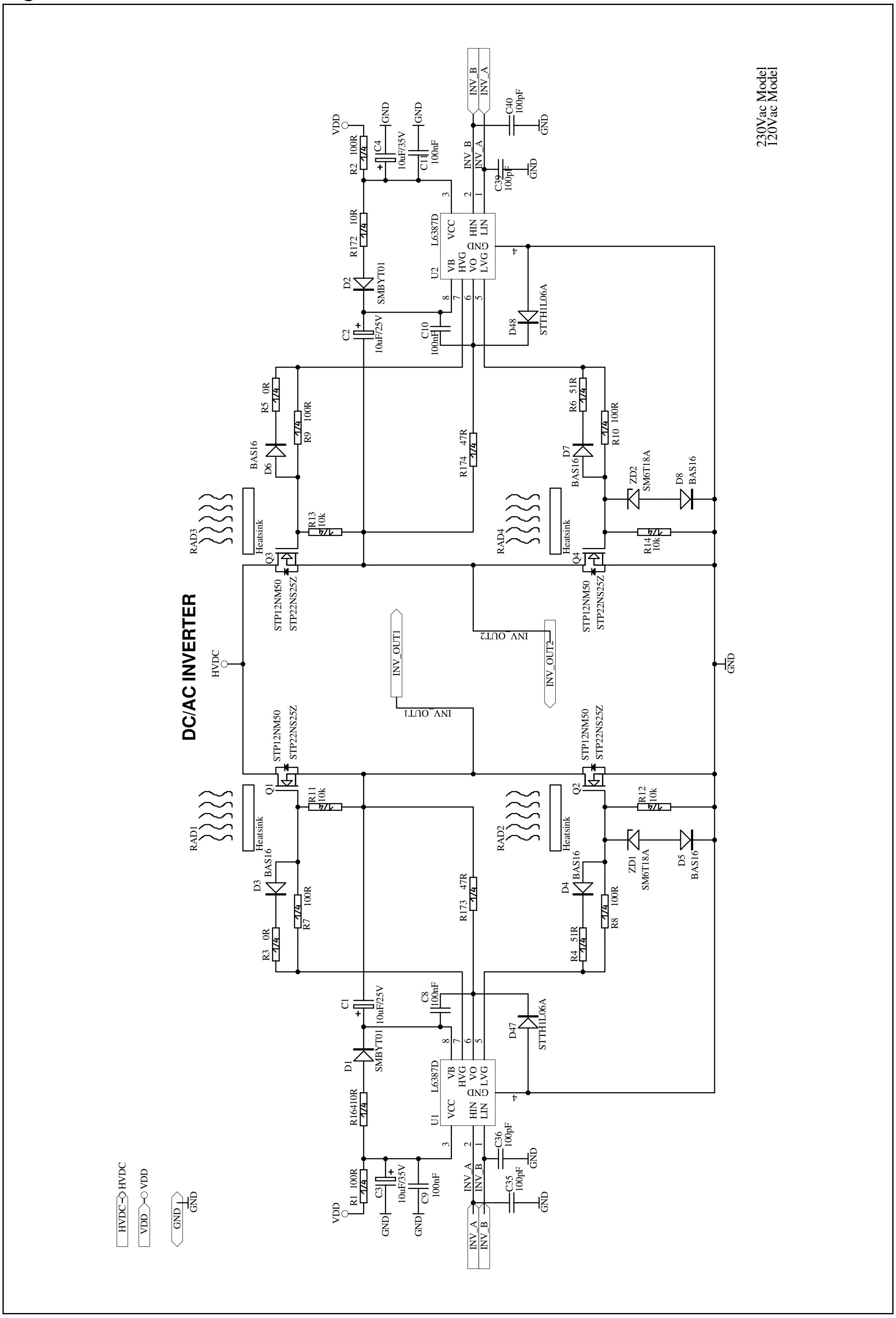
The converter is based on push-pull topology. The PWM controller works in voltage mode. The power components used for the low voltage side are switches 5 - 8 and a transformer. The energy recovery circuit includes L1, D1, L2, D2, C1 and R1. It works as both a clamp and a snubber. Power components on the secondary side are limited to rectifier diodes D3 - D6 and a small voltage smoothing capacitor. The output voltage is limited with direct control loop without insulation. An internal soft-start circuit is used to limit the voltage rise rate on the output of the DC/AC converter. The soft-start circuit is controlled from the microcontroller by an additional transistor. The PWM controller is powered from the main UPS power supply section. The output converter voltage range is battery voltage dependent and has been set to achieve maximum efficiency.

Table 1. DC/DC specification

DC/DC converter	120 Vac version	230 Vac version
Output voltage	130 – 190 V	250 - 360 V
Output power	450 W	450 W
Efficiency	> 80%	> 80%
Frequency	40 kHz ± 10%	40 kHz ± 10%
PWM controller U1	SG3525	SG3525
Power switches 5 – 8	STP75NF75	STP75NF75
Push-pull transformer T11	EE42	EE42
Rectifiers diodes D1 – D4	STTH803	STTH8R06

1.1.5 DC/AC inverter module

Figure 3. DC/AC inverter



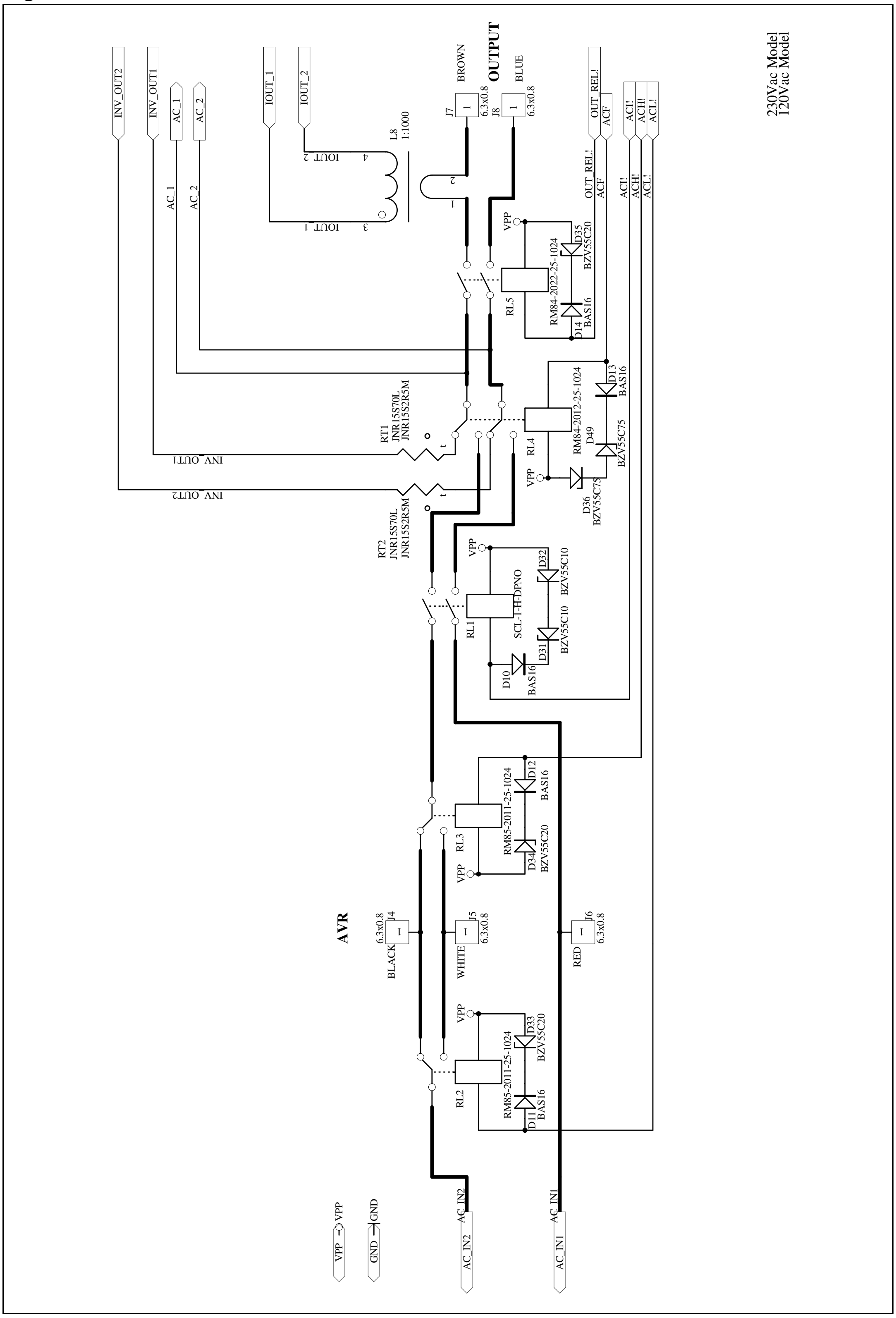
The DC/AC inverter was built in full-bridge topology. The output waveform is a quasi-sine waveform. The inverter is controlled by the microcontroller across two PWM drivers which switch four power transistors. The high-side driver parts are supplied with the bootstrap circuitry D1, C1 and D2, C2. The diodes D1 and D2 are high-voltage fast-recovery diodes. Switching off all transistors is achieved with driver internal logic if both INV_A and INV_B signals are set high or low. There is no any additional overcurrent protection for bridge transistors. Drivers are powered from the main UPS supply unit.

Table 2. DC/AC specification

DC/AC inverter	120 Vac version	230 Vac version
Output voltage RMS	120 Vac +5%/ -10%	230 Vac +5%/ -10%
Frequency (microcontroller outputs)	60 Hz ± 0.1 Hz	50 Hz ± 0.1Hz
Drivers U1, U2	L6387	L6387
Power switches Q1 – Q4	STP22NS25Z	STP12NM50
Bootstrap diode D1, D2	SMBYT01-400	SMBYT01-400

1.1.6 Power switches

Figure 4. Power switches



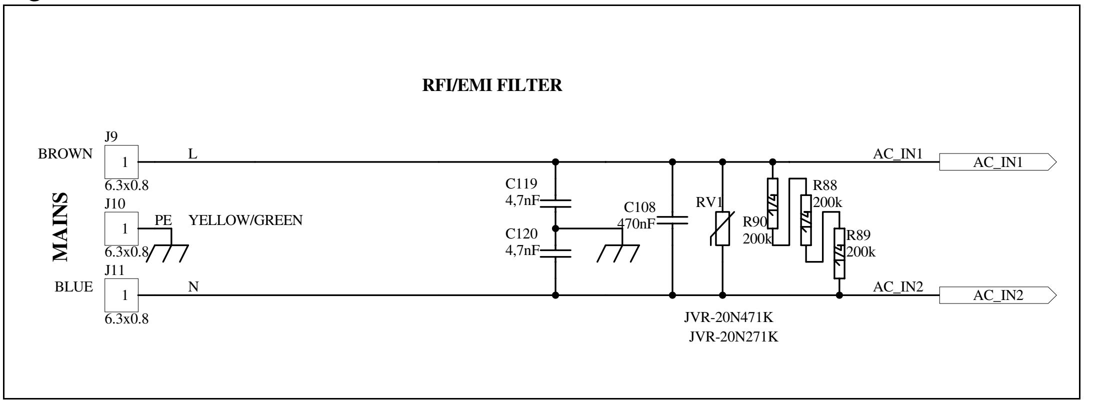
The power line contains:

- two pole separation relays DPNO (RL1) (with 2 mm gap)
- two relays DPDT (RL2, RL3)
- two pole switching battery/mains relays DPDT (RL4)
- two pole output on/off relays DPNO (RL5)

All relay coils are powered from the battery and charger voltage. The current transformer is used for monitoring UPS output current and power. The additional AVR boost/buck autotransformer has two sections: winding and output power 60VA. Relay coils are controlled by the microcontroller signals through an additional driver.

1.1.7 RFI/EMI filter

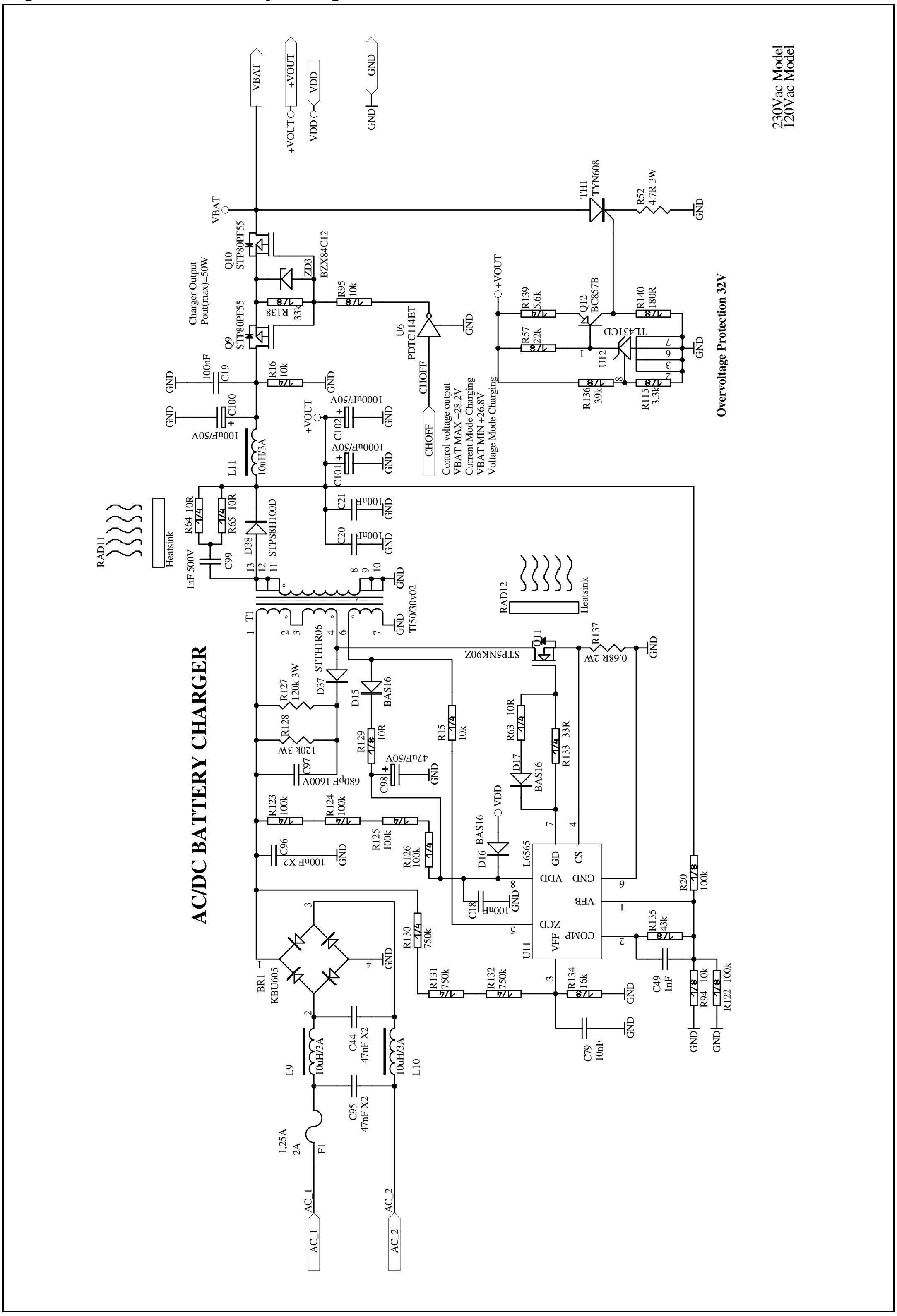
Figure 5. RFI/EMI filter



An additional EMI/RFI filter contains one X-type capacitor and a pair of Y-type capacitors.

1.1.8 Charger AC/DC

Figure 6. AC/DC battery charger



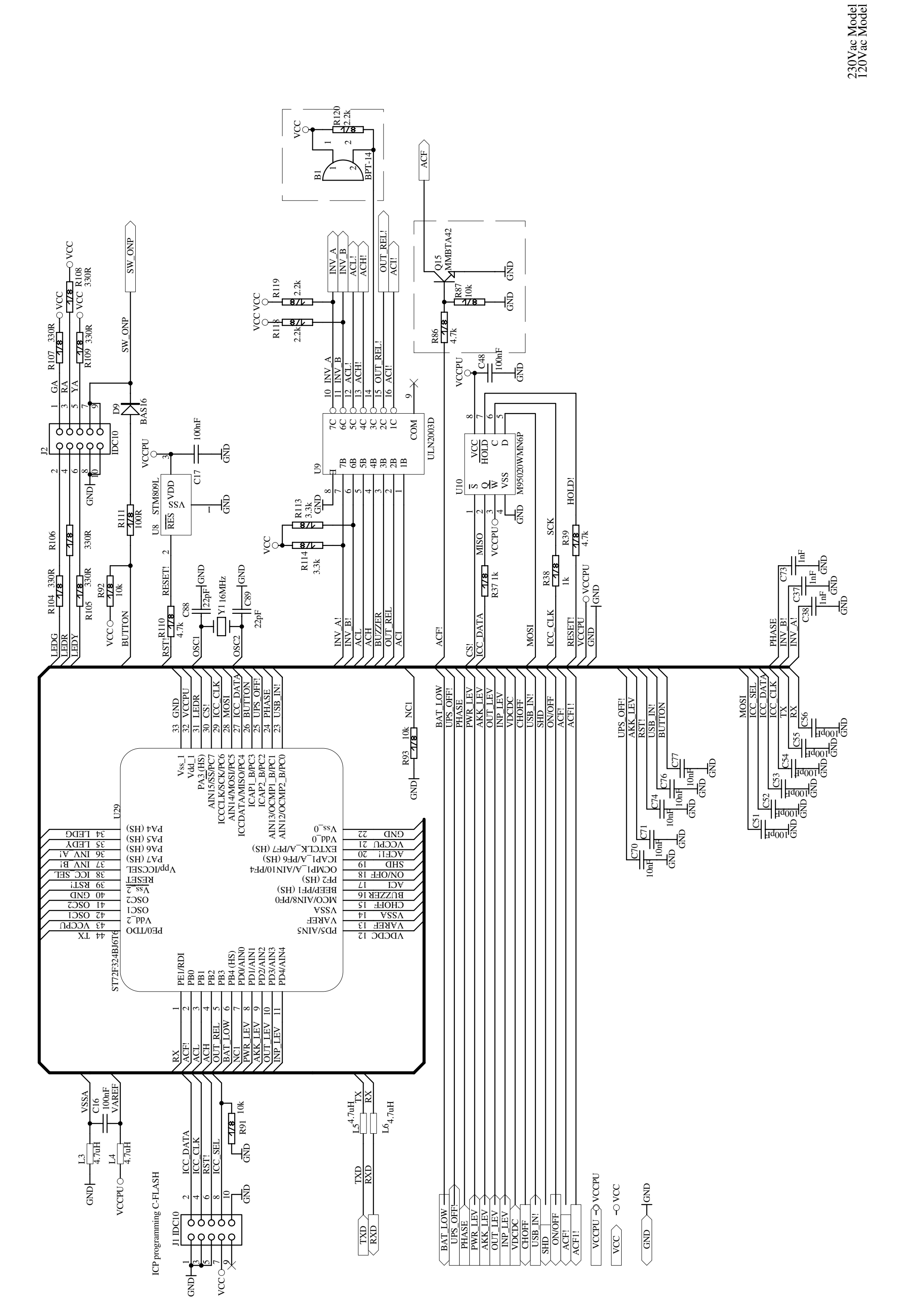
The battery charger is used as a battery charger for the mains mode or as a reactive power recirculation circuit for the inverter mode. For both modes the charger output power is accepted by the battery. The charger power converter is built in quasi-resonant flyback mode based on the controller L6565 with external power switch Q1 and output diode D1. The PWM controller is powered from the main UPS supply module and from the auxiliary winding on the flyback transformer. The transformer is designed with the ETD29 core. The CHOFF signal is used to switch (Q2 and Q3 STP80PF55) charging modes by the microcontroller. An additional output voltage loop limits open output charger voltage. The charger module also contains a battery overvoltage protection circuit with SCR TYN608 and voltage reference TL431.

Table 3. Battery charger specifications

AC/DC converter	120 Vac version	230 Vac version
Max output voltage	29 Vdc ± 5%	
Max output power	50 W	
Efficiency	>80%	
Minimal switching frequency	100kHz ± 10%	
Controller U1	L6565	
Power switch Q11	STP5NK90Z	
Transformer core	ETD29	
Rectifier diode D1	STPS8H100	
Clamp diode D3	STTA106	

1.1.9 Control unit

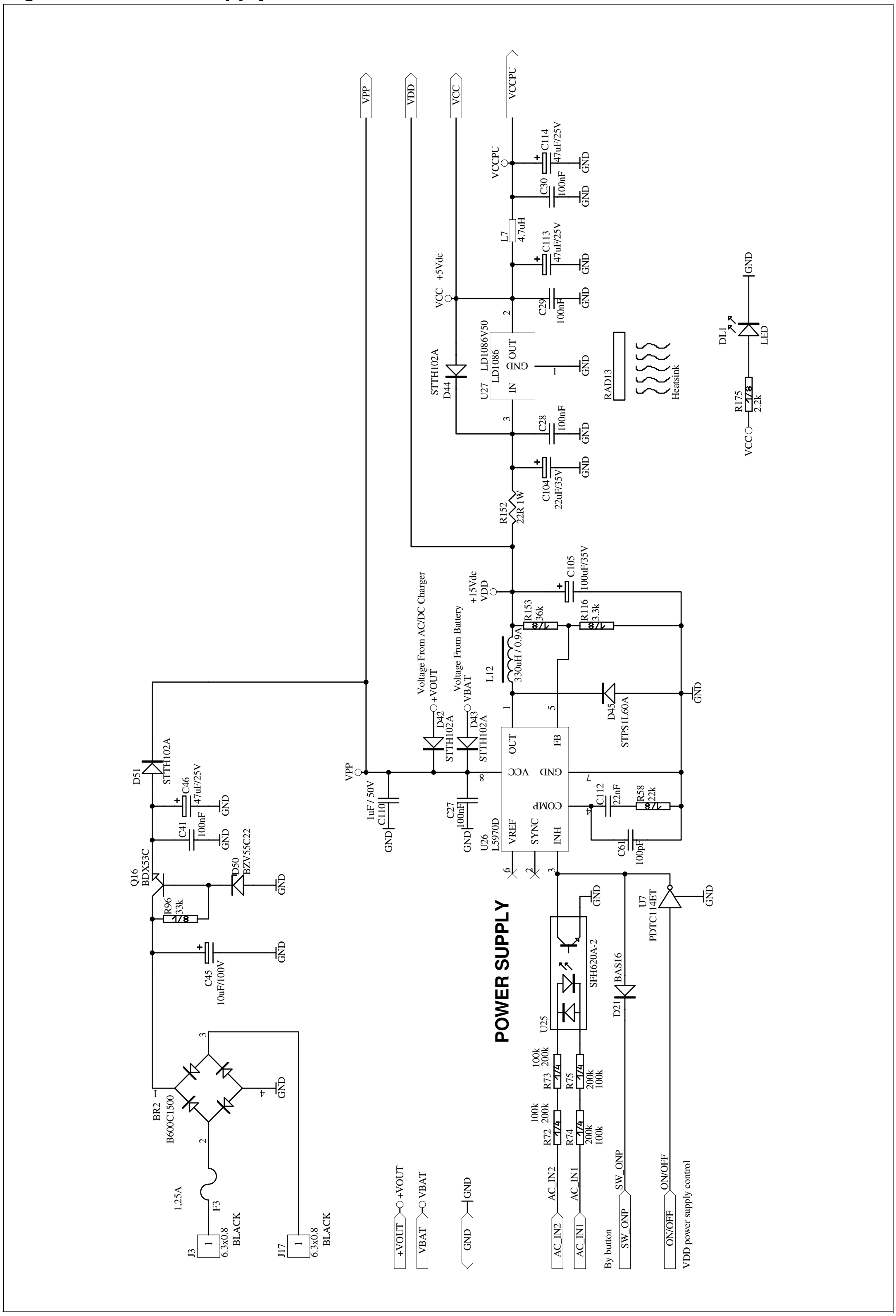
Figure 7. Control unit



The control unit contains the main microcontroller ST72F324J6T6 - in the TQFP 44 10x10 package with an ICP connector for programming, a reset STM809, a buffer ULN2003A for driving signals and an external EEPROM with SPI interface. Analog signals are measured with an internal 10-bit A/D converter. Digital inputs / outputs are used to control internal and external UPS signals. A thermistor is used to monitor internal UPS temperature.

1.1.10 Power supply

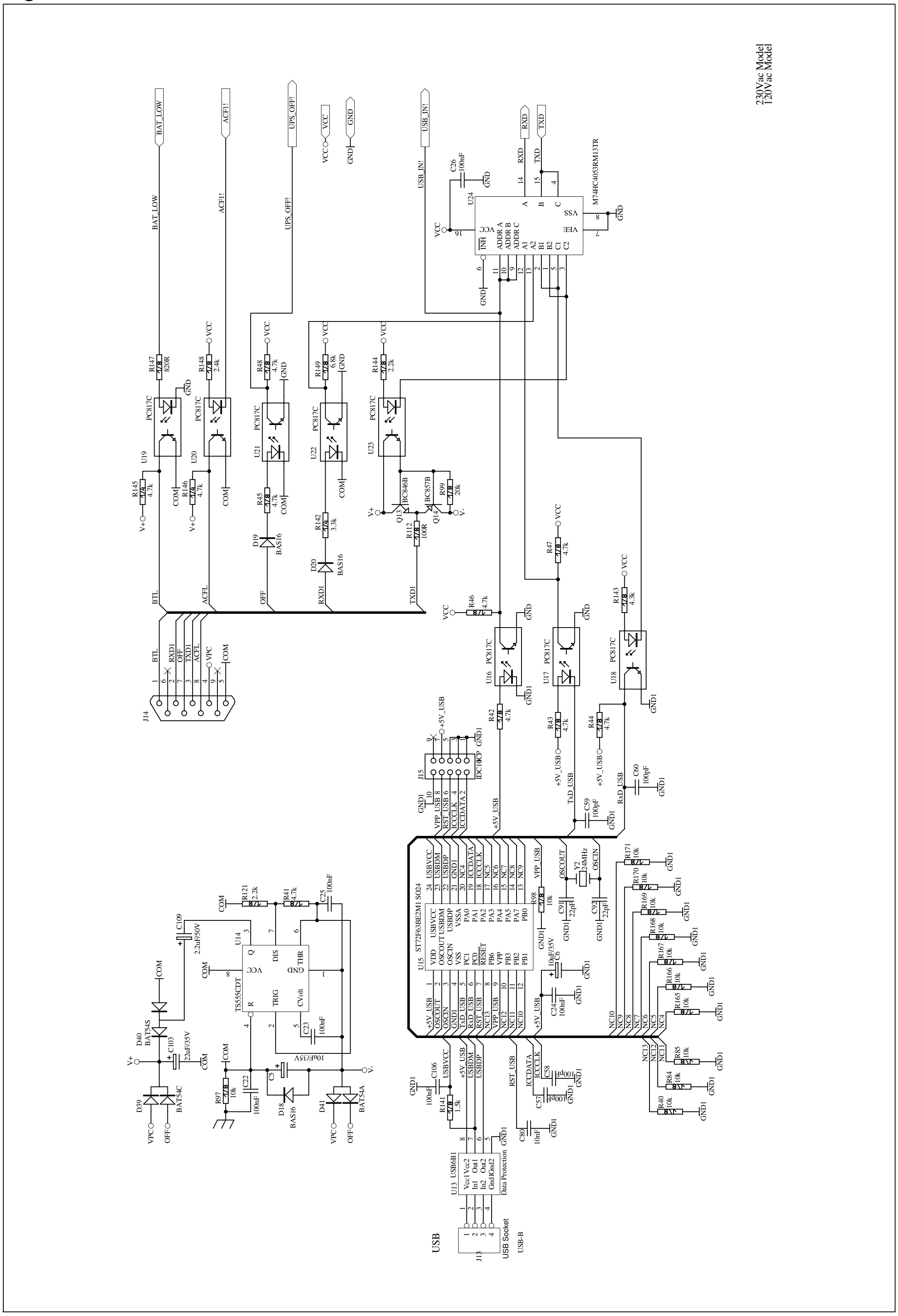
Figure 8. Power supply



The power supply unit provides two outputs used in UPS blocks: +15 V for most of the analog circuits and +5 V for the microcontroller. The switching voltage converter was built in step-down topology with an integrated regulator L5970. The microcontroller is supplied by linear regulator +5 V U3 LD1086V50. The switching regulator is controlled by the microcontroller ON / OFF signal and the BUTTON signal from the front panel ON/OFF switch. Additional supply is switched on by optocoupler SFH620 powered from the mains.

1.1.11 Interface

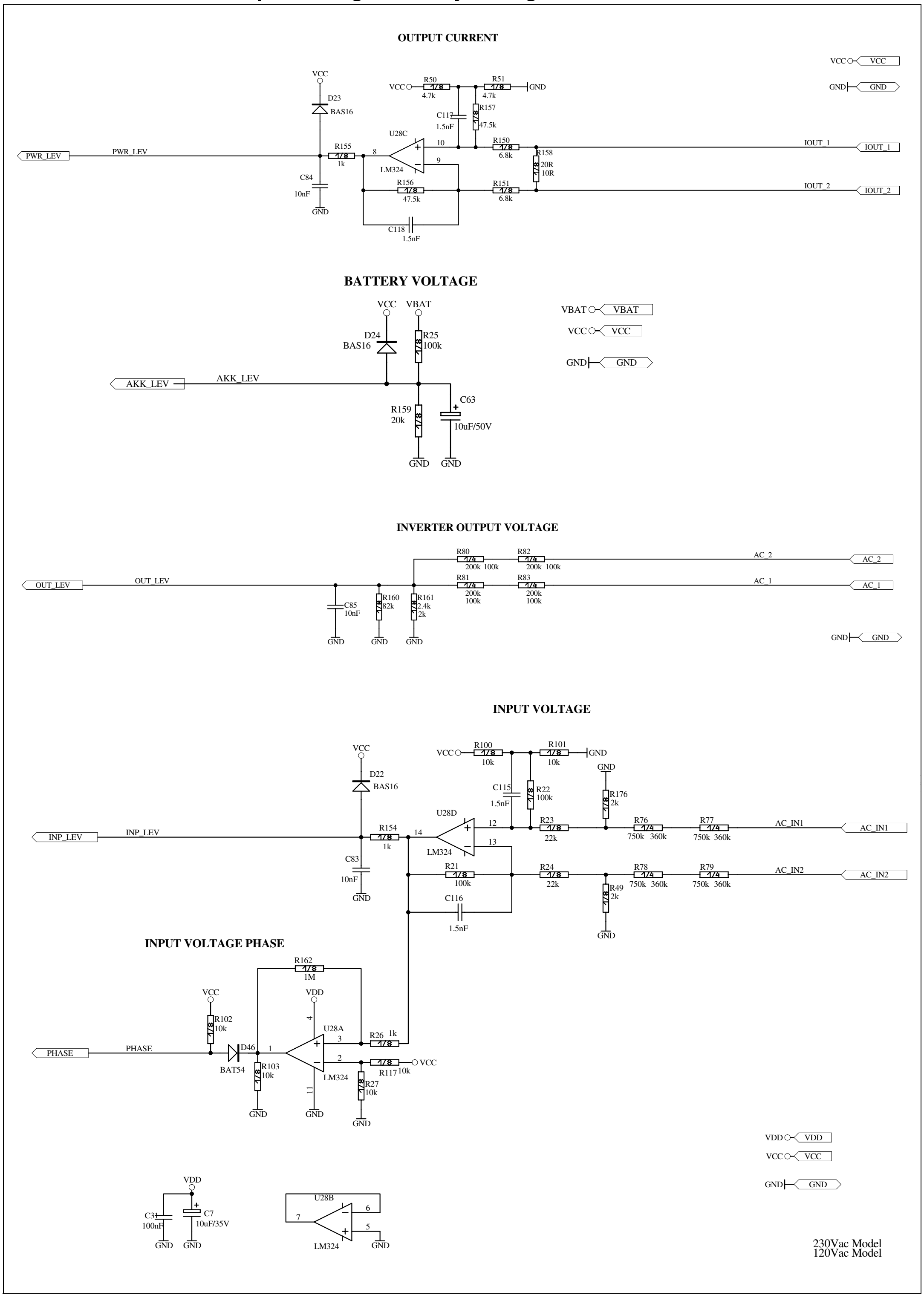
Figure 9. Interface



The interface unit provides the connection from the UPS unit to the PC via RS, USB or joint signals. The interface contains a USB to RS232 converter based on the microcontroller ST72F623F2M1, in the SO20 package powered from the PC, with optoisolation barrier (PC817B) and RS232 with optoisolation barrier (PC817B). The required voltage for the RS232 circuits is realized by the voltage pump converter built with NE555. The interface unit also contains an analog multi/demultiplexer M74HC4053 used to switch signals from the USB and RS232 to the microcontroller.

1.1.12 Measurements: input voltage, input voltage phase, output current, inverter output voltage, battery voltage

Figure 10. Measurements: input voltage, input voltage phase, output current, inverter output voltage, battery voltage



Referring to *Figure 10*, the measurements are defined as follows:

a) Output current. Input voltage measurement unit is built as a differential amplifier with a 2.5 V offset (LM324). The output signal from the amplifier is connected to the A/D converter in the microcontroller.

b) Battery voltage. The input voltage phase unit works as a comparator (LM324) and contains information about the sign of the input voltage waveform.

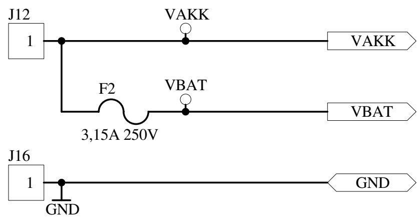
c) Inverter output voltage. Output current unit is built as a differential amplifier with 2.5 V offset (LM324). The output signal from the amplifier is connected to the A/D converter in the microcontroller.

d) Input voltage. The inverter output voltage is monitored through the voltage divider and connected to the microcontroller A/D converter input.

e) Input voltage phase. The battery voltage measurement uses a resistive voltage divider and the next A/D converter input of the microcontroller.

1.1.13 Battery overcurrent protection

Figure 11. Battery overcurrent protection



The battery overcurrent protection is given by a fuse.

1.1.14 Mains protection

The mains is protected by an automatic fuse mounted in an enclosure. If tripping occurs, the fuse can be reset by the UPS user.

1.1.15 UPS modes

Table 4. UPS modes

	Mains mode	Boost mode	Buck mode	Inverter mode	Standby mode	Standby charge mode	OFF mode
UPS input	On	On	On	Off	Off	On	Off
UPS output	On/off	On/off	On/off	On	Off	Off	Off
Battery charger	On	On	On	Off(1)	Off	On	Off
Inverter	Off	Off	Off	On	Off	Off	Off

Table 4. UPS modes (continued)

	Mains mode	Boost mode	Buck mode	Inverter mode	Standby mode	Standby charge mode	OFF mode
Power supply VDD and VCC	On	On	On	On	On	On	Off
Communication	On	On	On	On	On	On	Off

1. Programming microcontroller only

1.1.16 Microcontroller IN/OUT signals

Table 5. Microcontroller IN/OUT signals

Signal name	Port ST7	Pin no ST7	Type/active state	Description
LEDR	PA3	31	digital output/active low	Red LED control
LEDG	PA4	34	digital output/active low	Green LED control
LEDY	PA5	35	digital output/active low	Yellow LED control
INV_A!	PA6	36	digital output/active high	Inverter control
INV_B!	PA7	37	digital output/active high	Inverter control
ACF!	PB0	2	digital output/active low	Input voltage (mains) fail
ACL	PB1	3	digital output/active high	AVR boost control
ACH	PB2	4	digital output/active high	AVR buck control
OUT_REL	PB3	5	digital output/active high	UPS output on/off
BAT_LOW	PB4	6	digital output/active high	Battery low voltage
USB_IN!	PC0	23	digital input/active low	USB connected to source (PC) signal
PHASE	PC1	24	digital input/active high	Input voltage (mains) phase signal
UPS_OFF!	PC2	25	digital input/active low	The UPS output off – joint signal
BUTTON	PC3	26	digital input/active high	Button signal
ICC_DATA	PC4	27	SPI/ICC	Data input from external EEPROM / ICC data input (flash programming)
MOSI	PC5	28	SPI	Data output for external EEPROM
ICC_CLK	PC6	29	SPI/ICC	SPI clock / ICC clock output (flash programming)
Unused	PC7	30		
TERM	PD0	7	ADC analog input	Temperature sense
PWR_LEV	PD1	8	ADC analog input	Output current measurement signal
AKK_LEV	PD2	9	ADC analog input	Battery voltage measurement signal
OUT_LEV	PD3	10	ADC analog input	Inverter output voltage measurement signal
INP_LEV	PD4	11	ADC analog input	Input voltage measurement signal

Table 5. Microcontroller IN/OUT signals (continued)

Signal name	Port ST7	Pin no ST7	Type/active state	Description
VDCDC	PD5	12	ADC analog input	Converter DC/DC output voltage measurement signal
TX	PE0	44	SCI transmit data out	RS-232C TxD signal
RX	PE1	1	SCI receive data in	RS-232C RxD signal
CHOFF	PF0	15	digital output/active high	Battery charging mode control signal
BUZZER	PF1	16	digital output/active high	Buzzer signal
ACI	PF2	17	digital output/active high	Mains relay control signal
ON/OFF	PF4	18	digital output/active high	Power supply VDD on/off
SHD	PF6	19	output	Shutdown DC/DC converter signal
Unused	PF7	20		
ICC_SEL	TST/VPP	38	Input	ICC mode flash programming
RST!	RESET	39	input	Reset
OSC1	OSC1	42		Resonator oscillator inverter output
OSC2	OSC2	41		External clock input or resonator oscillator inverter input

1.1.17 Signals functions table

Table 6. Signals functions table

	Mains mode	Boost mode	Buck mode	Inverter mode	Standby mode	Standby charge mode	Off mode
ACI	H	H	H	L	L	H	L
ACF!	H	H	H	L	L	H	L
ACL	L	H	L	L	L	L	L
ACH	L	L	H	L	L	L	L
OUT_REL	L/H	L/H	L/H	H	L	L	L
INV_A!	L	L	L	Active	L	L	L
INV_B!	L	L	L	Active	L	L	L
SHD	L	L	L	Active	L	L	L
TERM	Active	Active	Active	Active	Active	Active	Inactive
CHOFF	Active	Active	Active	H	L	Active	Inactive
BUZZER	Active	Active	Active	Active	Active	Active	Inactive
ON/OFF	H	H	H	H	H	H	L
BUTTON	Active	Active	Active	Active	Active	Active	Active
LEDR	Active	Active	Active	Active	Active	Active	Inactive

Table 6. Signals functions table (continued)

	Mains mode	Boost mode	Buck mode	Inverter mode	Standby mode	Standby charge mode	Off mode
LEDG	Active	Active	Active	Active	Active	Active	Inactive
LEDY	Active	Active	Active	Active	Active	Active	Inactive
TX	Active	Active	Active	Active	Active	Active	Inactive
RX	Active	Active	Active	Active	Active	Active	Inactive
USB_IN!	H or L	H or L	H or L	H or L	H or L	H or L	L
BAT_LOW	L	L	L	H or L	H or L	L	L
UPS_OFF!	H or L	H or L	H or L	H or L	H	H	L
MOSI	Active	Active	Active	Active	Active	Active	Inactive
ICC_SEL	L	L	L	L	L	L	Active(1)
ICC_DATA/ MISO	L/ Active	L/ Active	L/ Active	L/ Active	L/ Active	L/ Active	Active(1)/ Inactive
ICC_CLK/ SCK	L/ Active	L/ Active	L/ Active	L/ Active	L/ Active	L/ Active	Active(1)/ Inactive
PHASE	Active	Active	Active	Active	Active	Active	Inactive
INP_LEV	Active	Active	Active	Active	Active	Active	Inactive
OUT_LEV	Inactive	Inactive	Inactive	Active	Inactive	Inactive	Inactive
PWR_LEV	Active	Active	Active	Active	Inactive	Inactive	Inactive

1. Programming microcontroller only

H - high level +5 Vdc

L - low level 0 Vdc

Active - active signal

Inactive - inactive signal

1.1.18 Detailed description of mechanics

The standard enclosure dimensions are as follows:

- Main PCB:
  - Dimensions: 230 x 160 mm
  - Type: double-sided GE (glass - epoxy), FR4 with SMOBC
- LEDs and button PCB:
  - Dimensions: 80 x 25 mm
  - Type: single-sided GE (glass - epoxy), FR4 with SMOBC

1.2 Software architecture

1.2.1 Data models

The setting of the UPS is stored in EEPROM memory. The data format is shown in *Table 7*:

Table 7. Memory mapping

Address	Name	Length (bytes)	Description
0	OFF_ADDR	1	Flag indicating state of UPS (on/off)
1	ATR_ADDR	1	Auto restart flag
2	SHUT_ADDR	1	Shutdown type
3	BATT_ADDR	1	Battery condition
4	ASHD_ADDR	1	Auto shutdown flag

1.2.2 Protocols

The SEC protocol is described briefly below. All messages sent between the PC and the UPS look like:

```
^<type><len><data>
```

where:

- ^ : the header character
- <type>: the type of message being sent

The PC sends the following message types to the UPS:

  – P: PC polls UPS (a query)
  – S: PC sets UPS variable

The UPS returns the following message types to the PC:

  – D: UPS returns data to PC (result of query)
  – 0: UPS rejected command sent from PC
  – 1: UPS accepted command sent from PC

- <len>: 3 characters length of following data (zero padded decimal ASCII)
- <data> - "len" characters of data

Commands are contained in the <data> field and are always 3 characters long. The orders supported are listed in *Table 8*.

Table 8. Poll commands

Query (3 characters)	Response (values separated by commas)
ATR	Auto restart: 0 - disabled or 1 - enabled
MAN	“ST”
MOD	“UPS reference design”
NOM	“230,500,230,500,700,450,1,1” for EU version and “120,600,120,600,700,450,1,1” for US version

Table 8. Poll commands

Query (3 characters)	Response (values separated by commas)
SDA	Shutdown type: 0 – output, 1 - system
ST1	Battery condition (0 – good, 1 – weak, 2 - replace), battery status (0 – normal, 1 – low, 2 - depleted), battery voltage (V/10), battery current (A/10)
ST2	Input num lines (1), mains frequency (Hz/10), mains voltage (V/10)
ST3	Output source (0 – normal, 1 – on battery, 3 – reducing, 4 – boosting, 5 – out off), output voltage (V/10), output current (A/10), output power (W)
STR	Test result summary (1 – passed, 2 – in progress, 4 – battery test fail)
AP1	"10,16,17,18,19,20,22,24,43"
AP2	"51,58,59,60,61,62,63,64,65,68,73,76,77,80,82,83,84,85,87"
VER	"V 1-0-0-0 w"

Table 9. Set commands

Query (3 characters)	Response (values separated by commas)
ATR	Auto restart: 0 - disabled or 1 - enabled
SDA	Shutdown type: 0 – output, 1 - system
PSD	Shutdown after delay (if parameter > 0: second to shutdown, if parameter = -1: cancel shutdown)
RWD	Reboot with duration (parameter – seconds to startup after shutdown)
STD	Startup after delay (parameter – seconds to startup)
TST	Battery test: 1 – test or -1 – cancel test

Table 10. Additionally UPS support order not defined in SEC protocol

Query (3 chars)	Response (values separated by commas)
ASH	Auto shutdown: 0 – disabled, 1 – enabled or poll. UPS is shut down when output current is less than or equal to 100 mA.

1.2.3 System architecture

1.2.4 Main loop

- The UPS works in 7 modes:
  - Inverter mode - if the mains voltage is lower than 167 VAC RMS(87 for US version) or higher than 286 VAC RMS(153 for US version) the inverter is switched on. At outputs INV_B and INV_A, a PWM signal 50 Hz (60 for US version) with 40% or less duty cycles (depends on DC/DC output voltage) is generated. In inverter mode the ACF signal is switched on. If the mains voltage returns to the correct value (167 - 286 VAC or 87 - 153 VAC for US version), the PWM signal is

synchronized with the mains, the ACF! signal is set to low and the inverter is switched off.

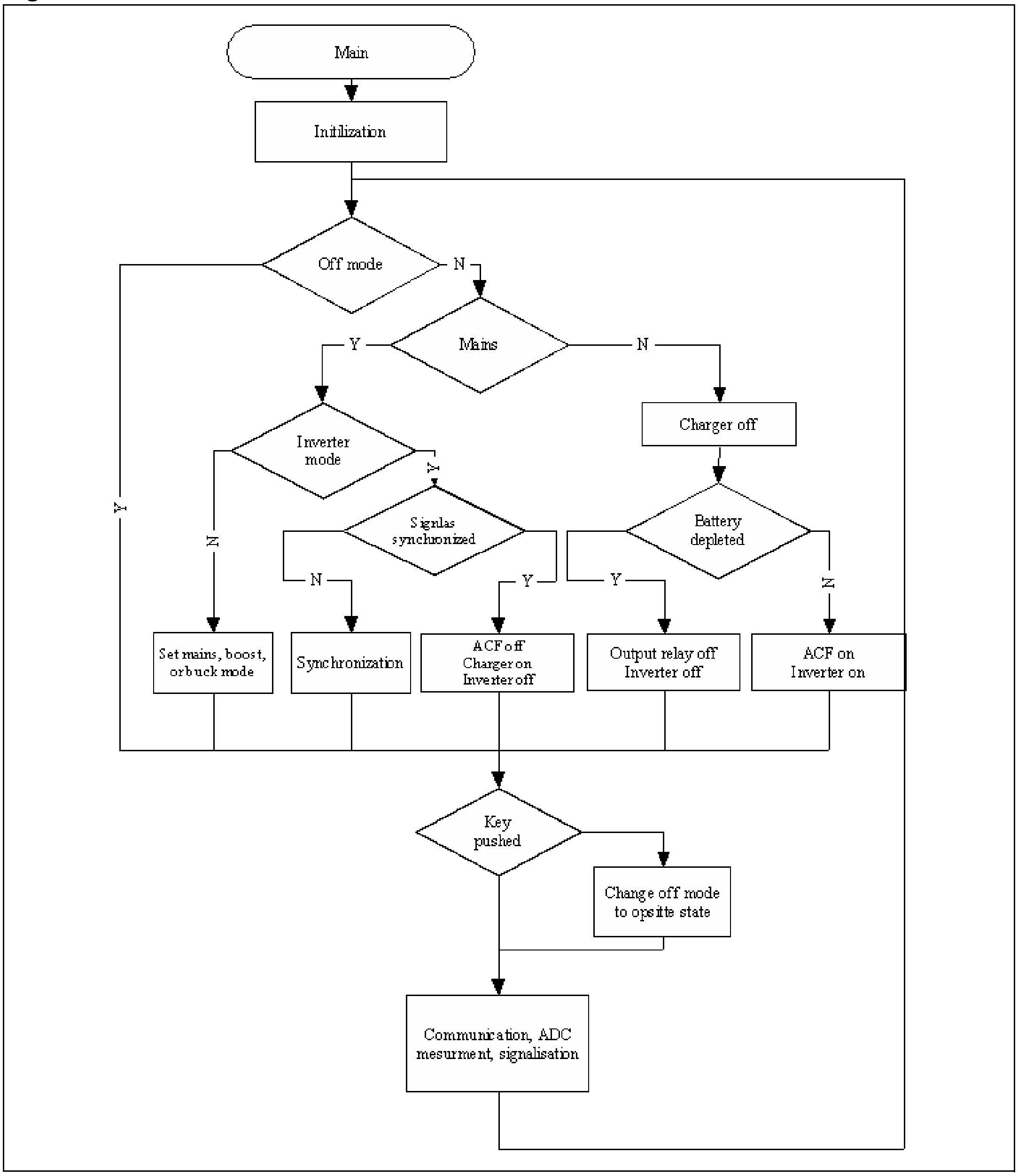
- Mains mode - in this mode the battery charger is switched on and the UPS is supplied from the mains. The inverter is switched off (INV_A and INV_B are in low state), and ACF! is high.
- Buck mode - in this mode the battery charger is switched on and the UPS is supplied from the mains. The ACH signal is switched on, the inverter is switched off, ACF! is high and the ACL signal is in low state.
- Boost mode - in this mode the battery charger is switched on and the UPS is supplied from the mains. The ACL signal is switched on, the inverter is switched off, ACF! is high and the ACH signal is in low state.
- Standby mode - in this mode the battery charger is switched off and the UPS is supplied from the battery. ACH and ACL are in low state, ACF! is low, CHOFF is high, and the inverter is switched off.
- Standby charge mode - the UPS is in this state when the mains is lower than the low level boost mode. ACH and ACL are in low state, ACF! is high, CHOFF is low, and the inverter is switched off.
- OFF mode - the UPS in this mode is totally switched off. This state is availably only in battery mode after pressing the on/off key longer than 4 seconds.

Additionally the UPS tests the battery. The battery test is done by switching to the inverter mode. During the test the MCU measures UPS output load and battery voltage. If the battery voltage during the test falls below the limit, the battery is failing. The value of the limit depends on time and load current. The test can be forced by the user with a PC. The battery condition can by checked after switching to the inverter mode without forcing the test. A load is necessary to test the battery.

Table 11. Signal state in different modes

Work mode	INV_A	INV_B	ACH	ACL	ACF!	CHOFF	SHD
Inverter mode	50 Hz (60 for US version) PWM signal (less than 40% duty cycle)	50 Hz (60 for US version) PWM signal (less than 40% duty cycle)	L	L	L	L	Signal is switched to L after rising edge INV_A or INV_B and switched to H before falling edge INV_A or INV_B.
Mains mode	L	L	L	L	H	Depends on battery voltage	H
Buck mode	L	L	L	H	H		H
Boost mode	L	L	H	L	H		H
Standby mode	L	L	L	L	L	H	H
Standby charge mode	L	L	L	L	H	Depends on battery voltage	H
Off mode	L	L	L	L	H	L	L

Figure 12. Main flowchart



1.2.5 ADC

The ADC thread measures values as described below:

- Mains voltage - the voltage measured at INP_LEV is needed for calculating the following values:
  - RMS - true RMS main voltage which determines the working mode of the UPS: mains mode, buck mode, boost mode or inverter mode. This value is calculated for one period of input voltage.
  - SAMPLE - actual sample voltage which is the value needed for calculating RMS. Additionally this value is needed to compare with the predicted value of the mains

value. The result of the comparison is used to make the decision to change the working mode from the mains to the inverter.

– Battery voltage - the value measured at AKK_LEV input determines the process of charging and discharging the battery. The value is averaged. During battery operation a signal is needed to indicate a low level of the battery or to protect the battery. In mains mode this value determines the charger's working mode.

Table 12. Battery state

Battery voltage	BAT_LOW
>=21.75 V (+/- 1%)	L
< 21.75 V (+/- 1%)	H

In DC/DC converter voltage the value is not averaged and is used to check if “out” is in short-circuit state.

During load current the value is measured at PWR_LEV input. The value is needed for calculating the power of the load (RMS for one period), battery current, overloading.

1.2.6 Communication

The thread of communication is in charge of communication to the PC. This thread completes the packet from the PC and sends answers. Received packets are interpreted in the main loop.

1.2.7 SPI

SPI interface is using for communication to EEPROM memory. SPI needs four signals: MISO, MOSI, SCK and CS. In inactive state all signals are high.

1.2.8 Keyboard

The keyboard contains only one key button connected to BUTTON input active low. The reaction for this signal depends on the working mode:

Table 13. Working modes

No	Working mode	State	Action	Reaction	
		OUT_REL	BUTTON L time	OUT_REL	ON/OFF
1	Mains/boost/buck mode	H	Short	No change	H
2	Mains/boost/buck mode	H	Long	Fall to L	H
3	Mains/boost/buck mode	L	Short	Rise to H	H
4	Mains/boost/buck mode	L	Long	Rise to H	H
5	Inverter mode	H	Short	No change	H
6	Inverter mode	H	Long	Fall to L	H
7	Inverter mode	H	Double long		Fall to L

Table 13. Working modes (continued)

No	Working mode	State	Action	Reaction	
		OUT_REL	BUTTON L time	OUT_REL	ON/OFF
8	Off	L	Short	L	H
9	Off	L	Long	Rise to H	H

Note: Long = 2 s, Short = 20 ms

Additionally the state of OUT_REL is stored in EEPROM memory and restored after a cold start independent of the AUTOSTART setting.

1.2.9 LEDs

LEDs indicates the state of the UPS. The active state is H.

Table 14. LED states

State	LED green	LED yellow	LED red
Mains mode	L	H	H
Battery mode	H	L	H
Low battery in battery mode	H	2 Hz 50% duty cycle	H
Buck/boost mode	2 Hz 50% duty cycle	H	H
Battery charging	L	2 Hz 50% duty cycle	H
Overload (mains)	L	H	2 Hz 50% duty cycle
Overload (battery)	H	L	2 Hz 50% duty cycle
Self test	L	L	H
Fault (mains)	L	H	L
Fault (battery)	H	L	L
Standby mode	H	H	0,5 Hz 50% duty cycle

1.2.10 Charger

The battery charger works in two steps: constant current charging and hysteresis constant voltage. In the constant current step, the battery is charging in current mode until the voltage of the battery is lower than 28.2 VDC. In the second step, the charger is switched on when the battery voltage is lower than 26.8 VDC and switched off if the value is higher than 27.8 VDC. The microcontroller controls the process by switching the CHOFF signal.

Table 15. Battery charge modes

Step of charge process	Battery voltage	CHOFF	Description
Current mode charging	< 28,2 V	L	Charging mode active only after battery working mode.
	>= 28,2 V	H	Switch to buffered working mode.

Table 15. **Battery charge modes (continued)**

Step of charge process	Battery voltage	CHOFF	Description
Buffered working mode	< 26,8	L	
	>= 27,8	H	

1.2.11 Inverter

The inverter is controlled by signals generated by the PWM module. In battery working mode the microcontroller generates two signals: INV_A and INV_B. The frequency depends on the firmware version: EU - 50 Hz, US - 60 Hz. The duty cycle is less than 50% and depends on the voltage of the DC/DC converter. The phase of the INV_B signal has to be shifted by a half time period to INV_A. The inverter is controlled by a timer interrupt. The frequency of the interrupt is 32 times higher than the mains frequency: every half-period is divided into 16 steps, and the number of steps is stored in a global variable.

Before any steps the SHD signals are checked and if they are inactive (H), the inverter signals are switched off (rise to H).

Table 16. **SHD signals**

Step no	SHD	Description
1	Fall to L	Proper inverter signal falls to L.
2 - 13	L	In any steps the squared value of the output voltage accumulates. The accumulated value is compared with the nominal RMS output constant, and if it is greater, the SHD signal rises to H.
14 - 15	H	
16	H	The accumulated value of the output voltage is cleared, the variable storing a step is not cleared. The inverter phase is changed to the opposite state.

2 Technical description

2.1 Circuit diagram

Figure 13. Circuit diagram

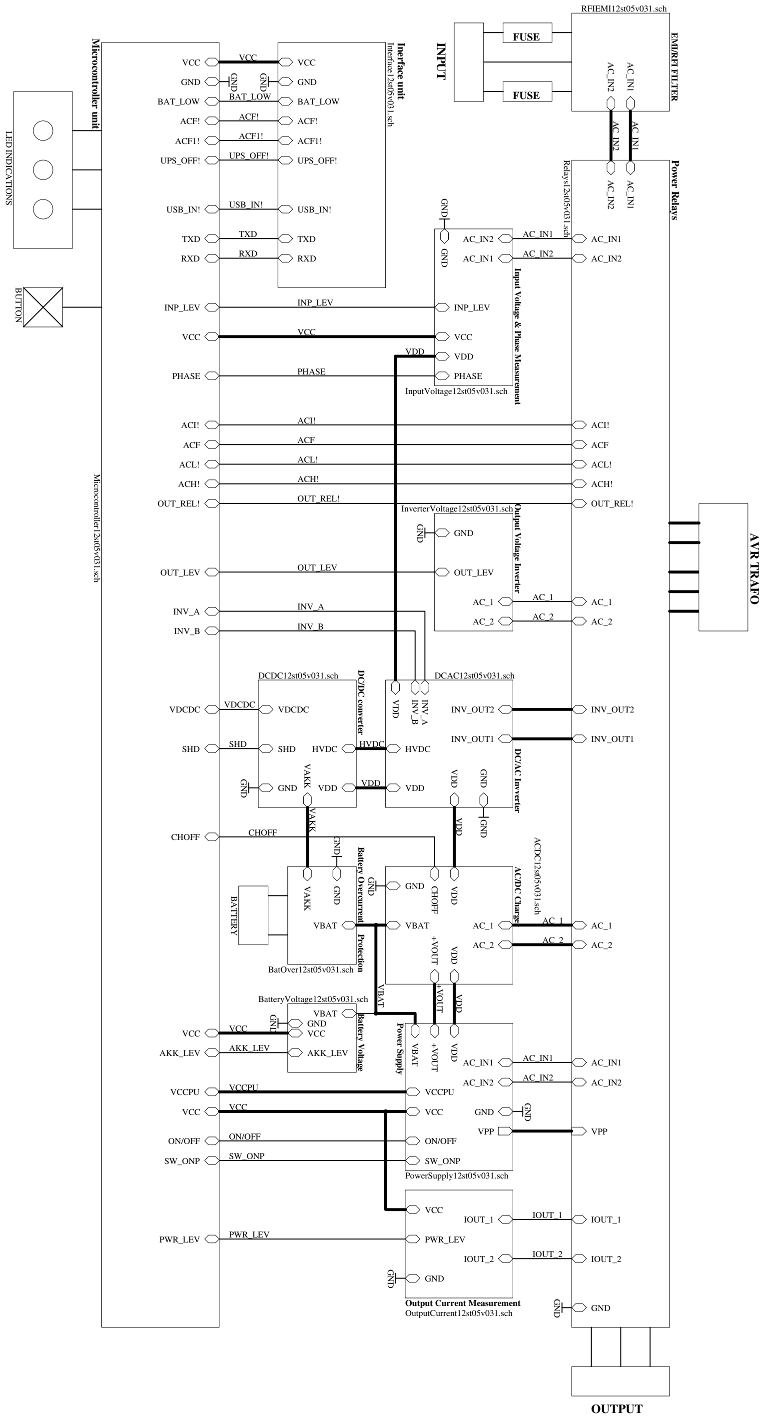


Figure 14. DC/AC inverter

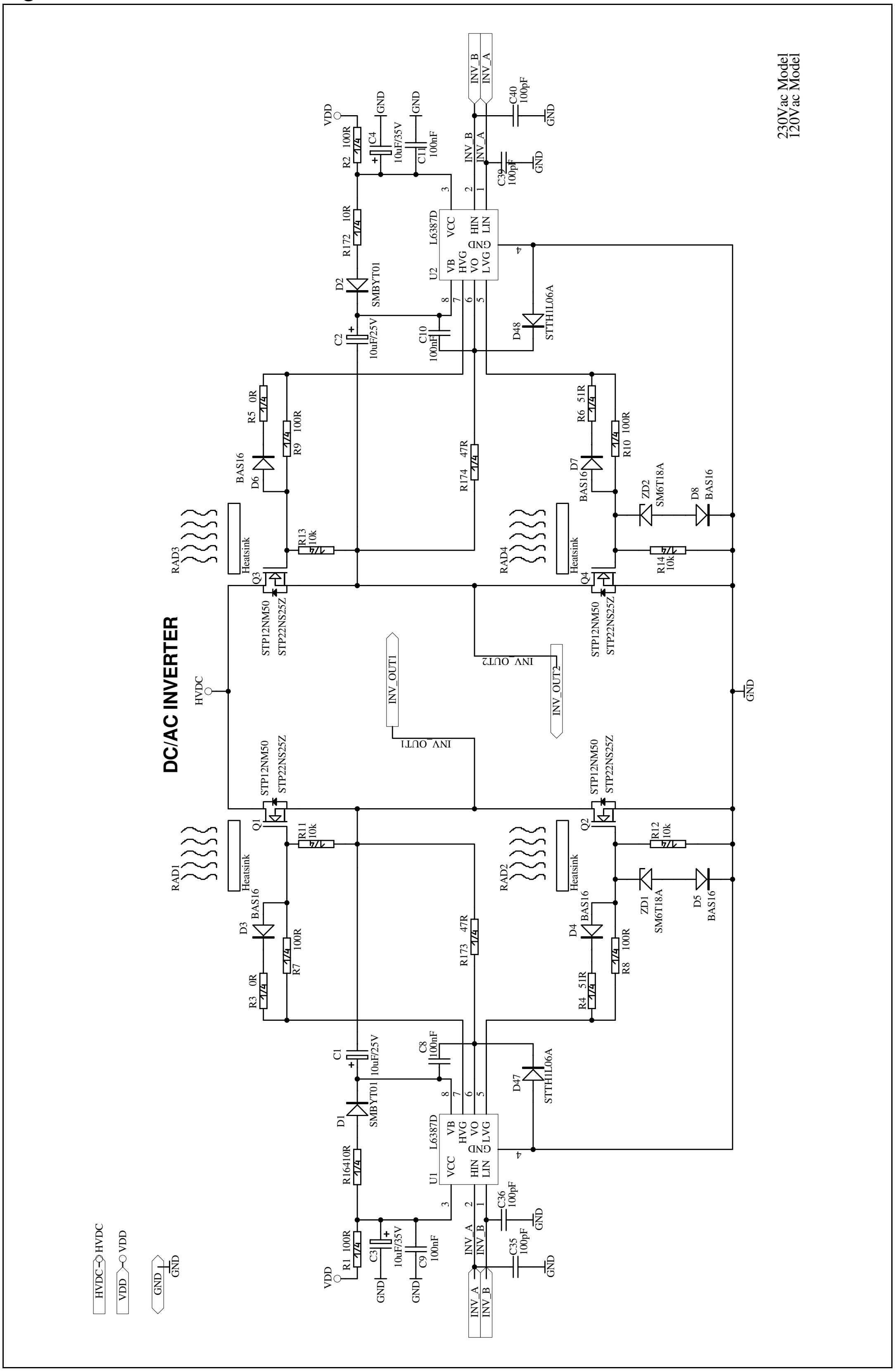


Figure 15. DC/DC converter

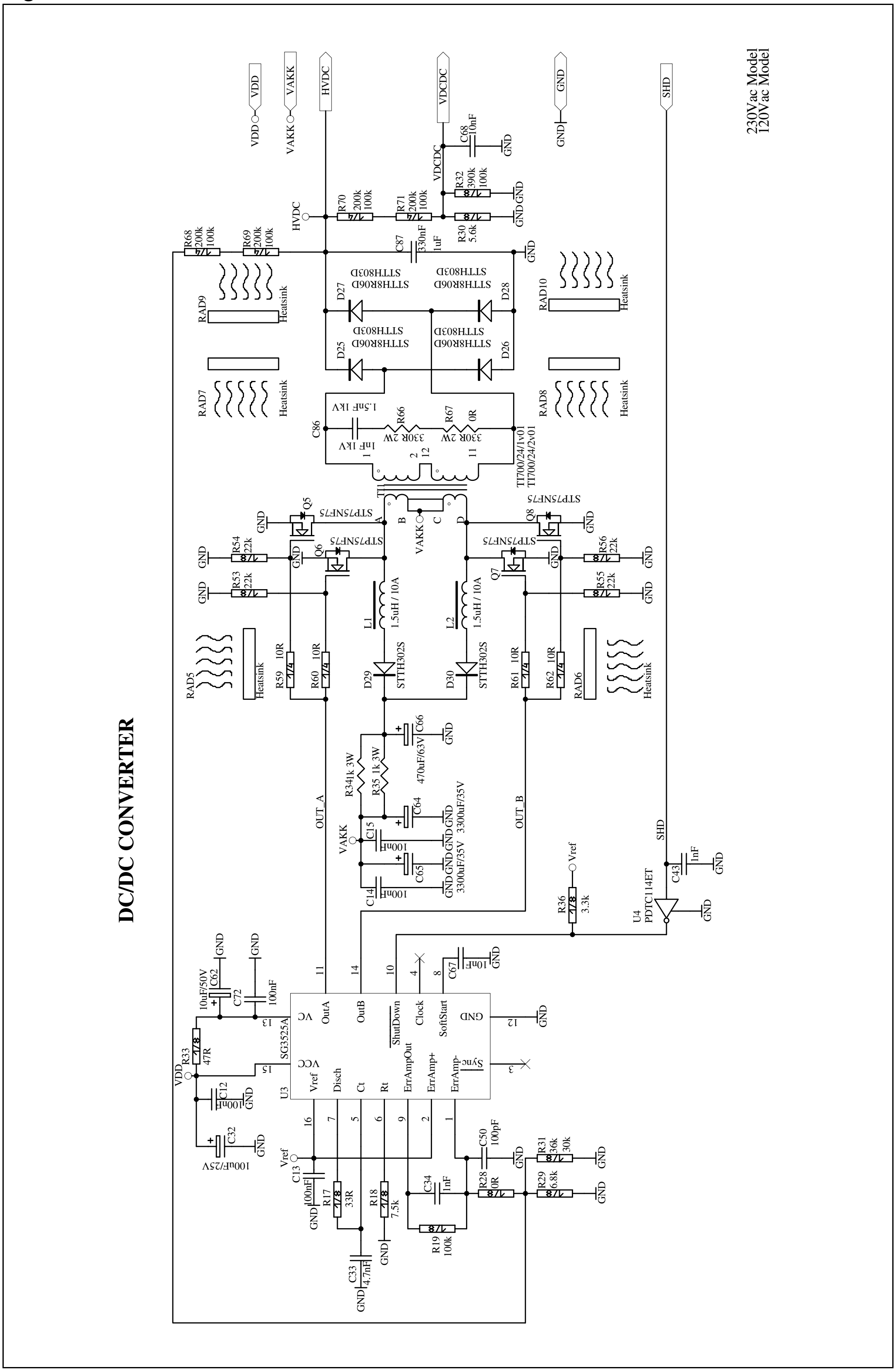


Figure 16. Control unit

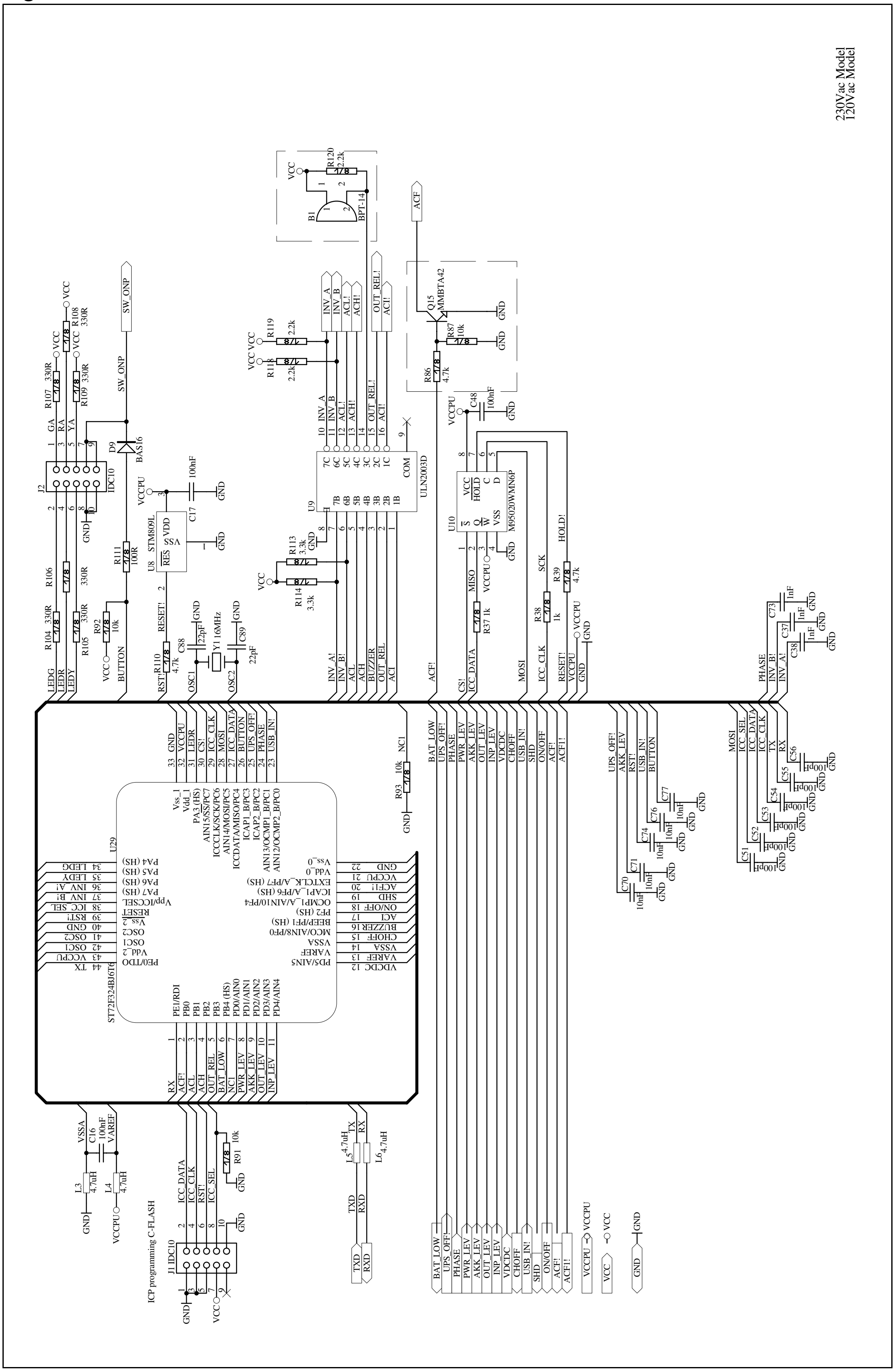


Figure 17. Power switches

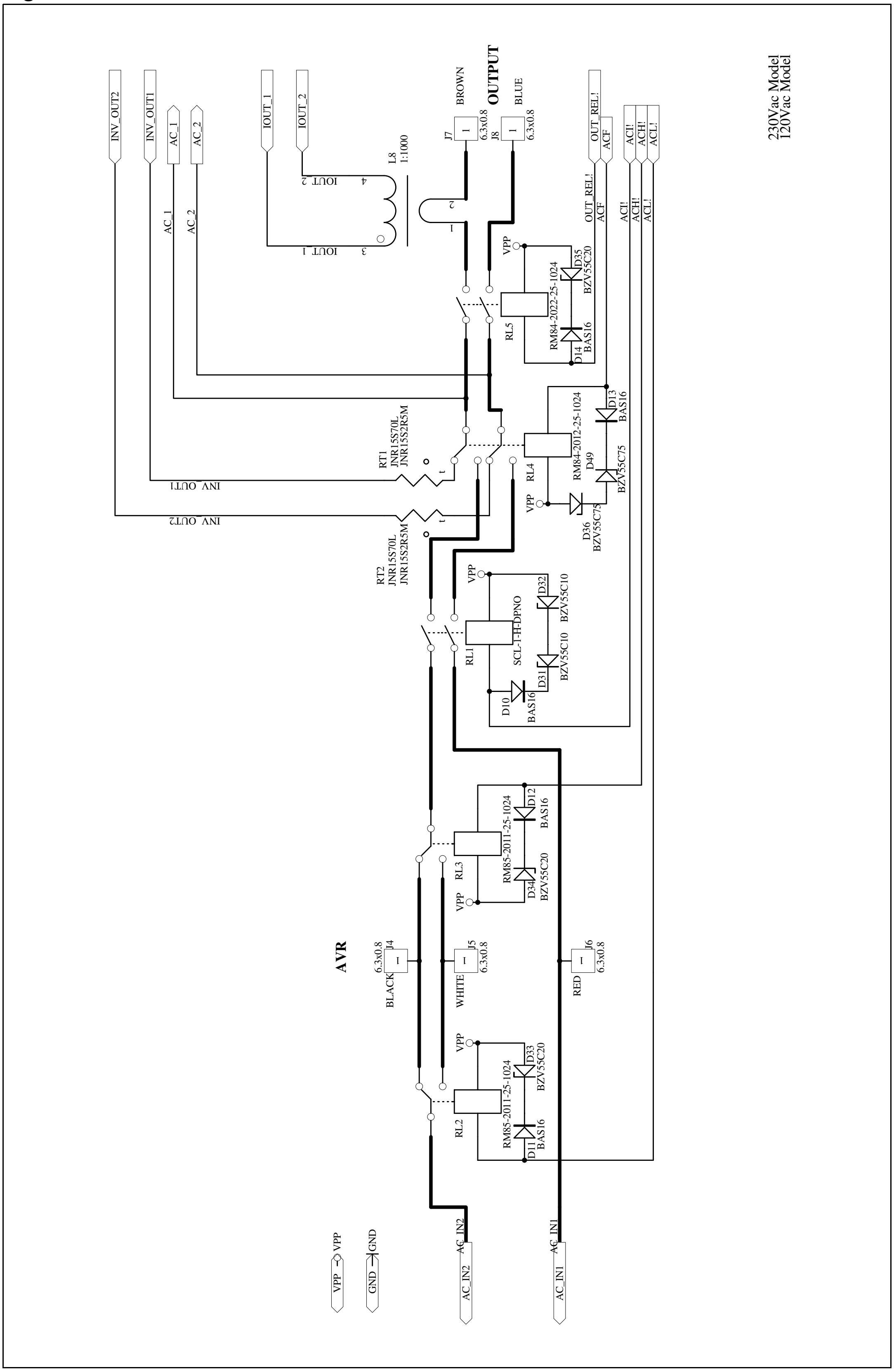


Figure 18. AC/DC battery charger

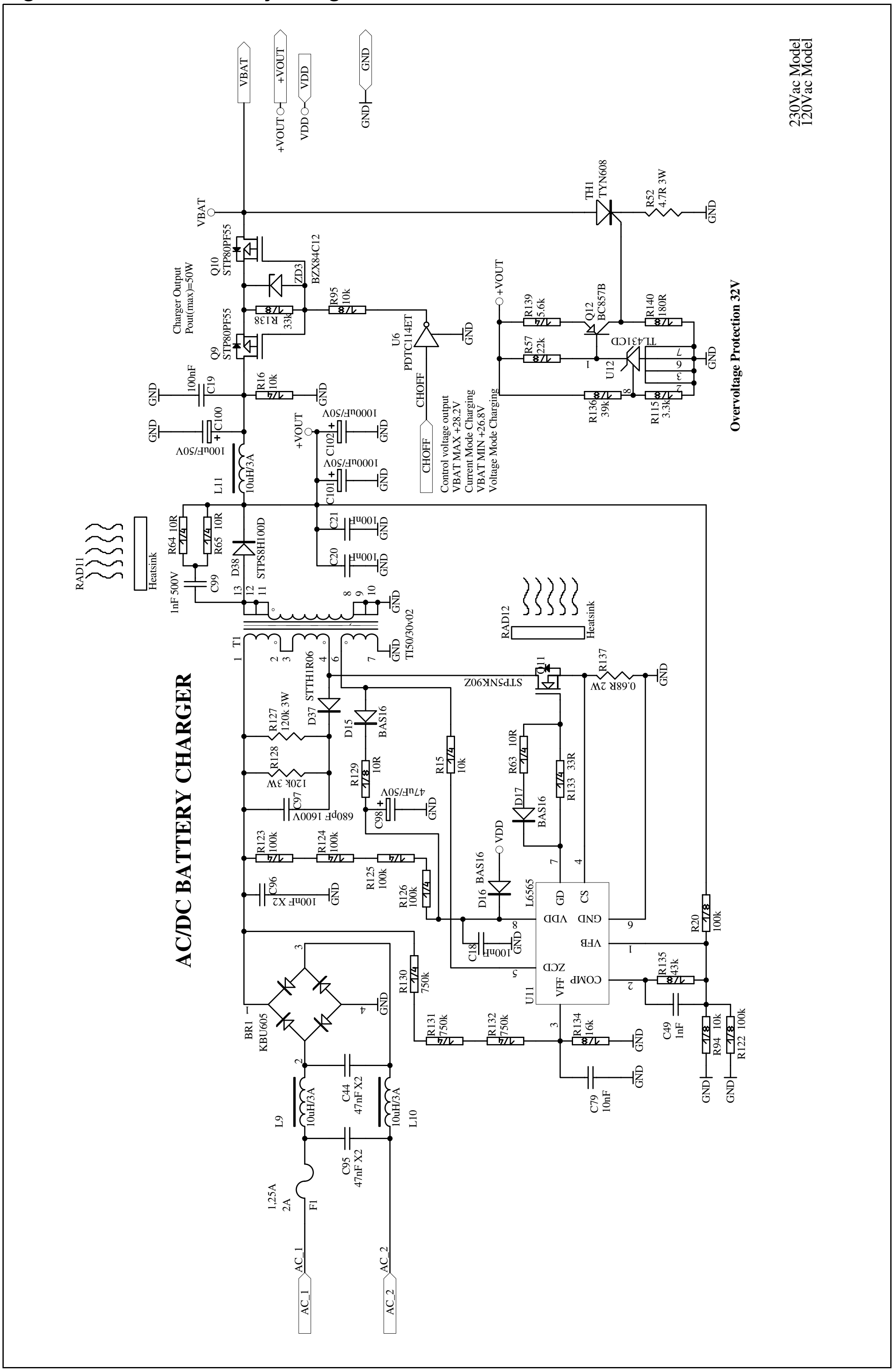


Figure 19. PC interface stage

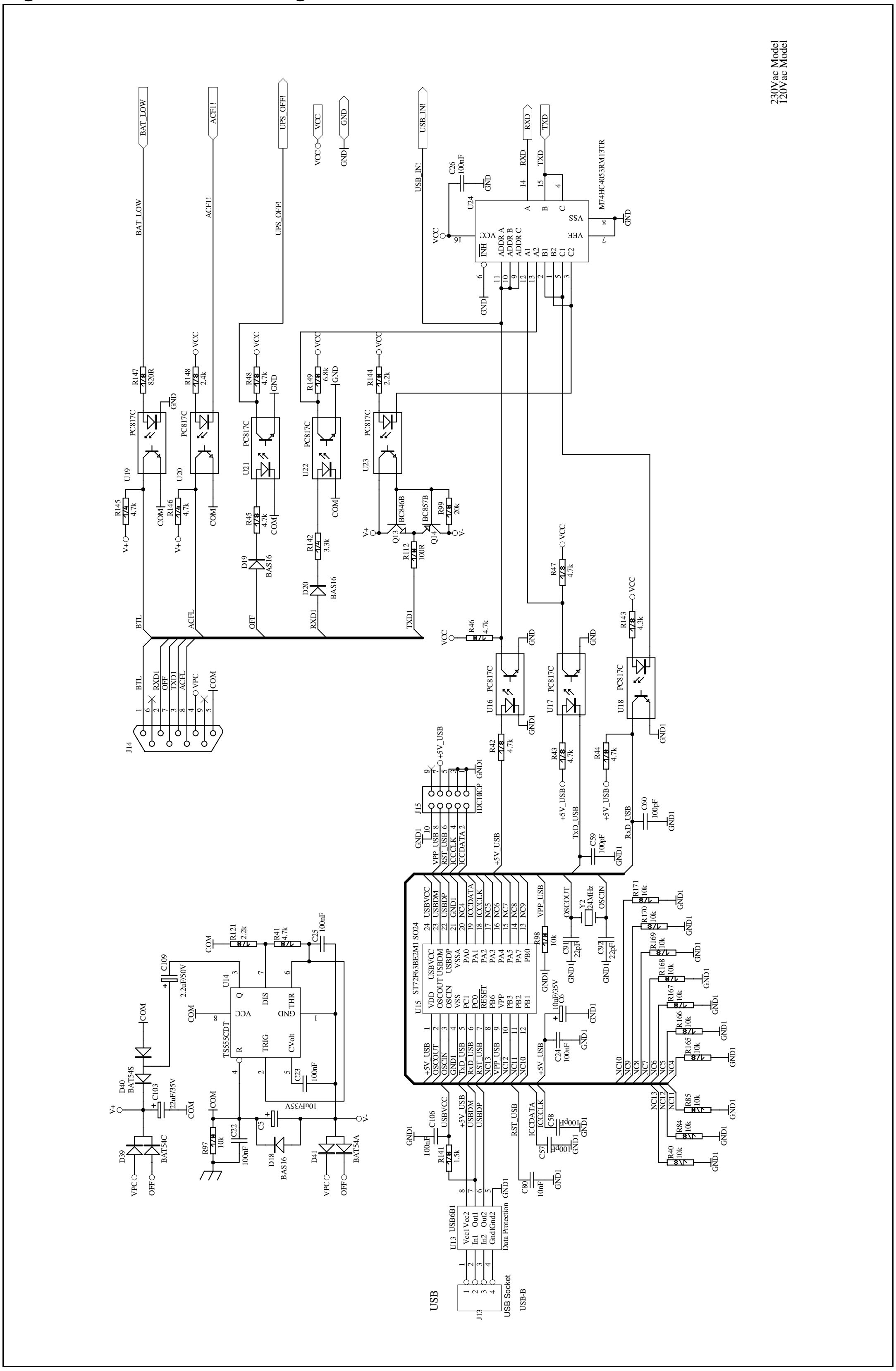


Figure 20. Power supply

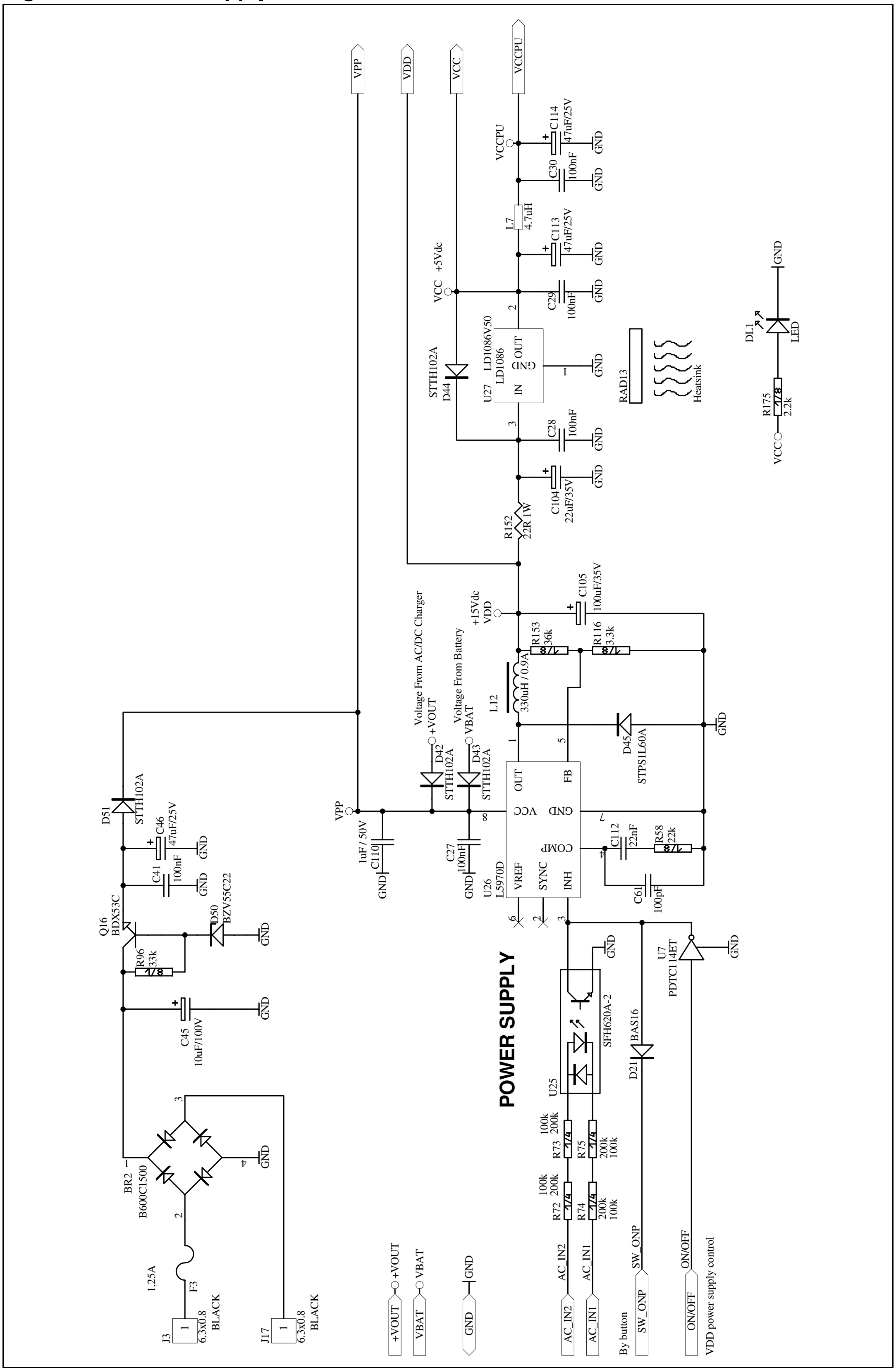


Figure 21. Measurement stages

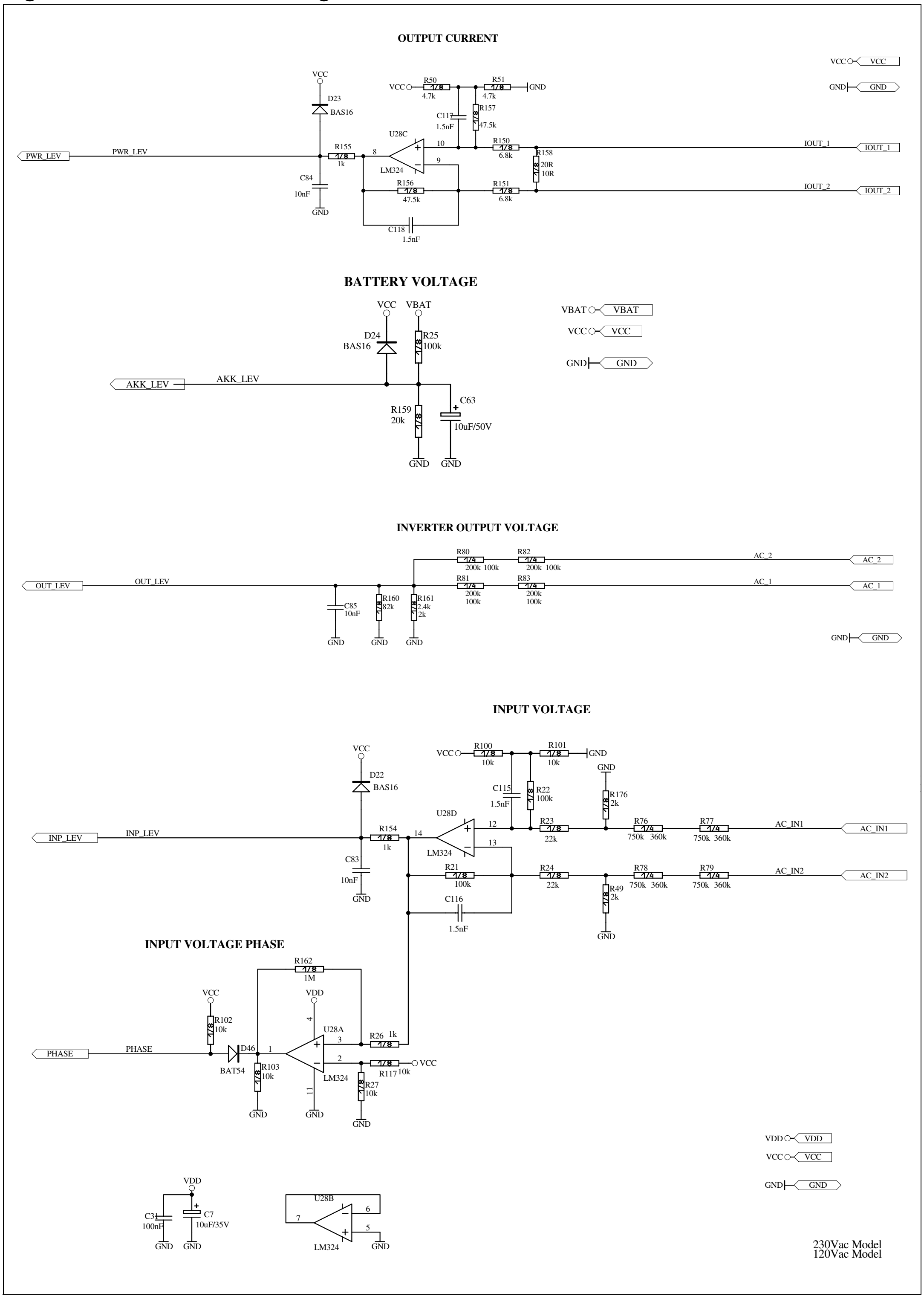


Figure 22. RFI/EMI filter

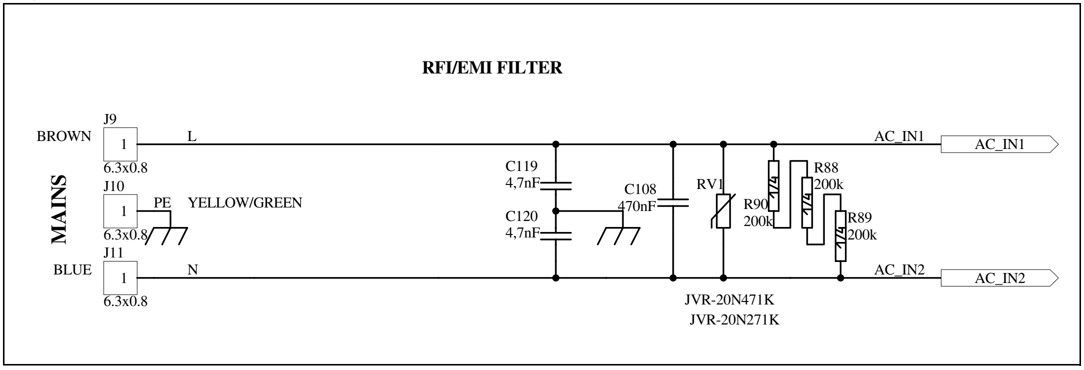
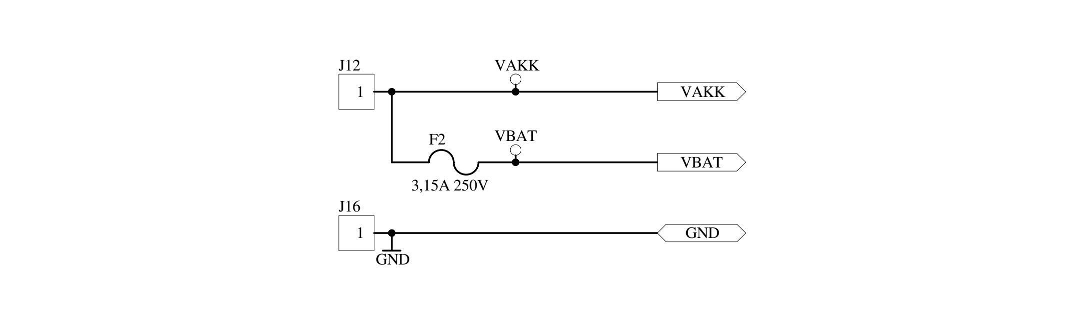


Figure 23. Battery overcurrent protection



2.2 Layout

Figure 24. Top view

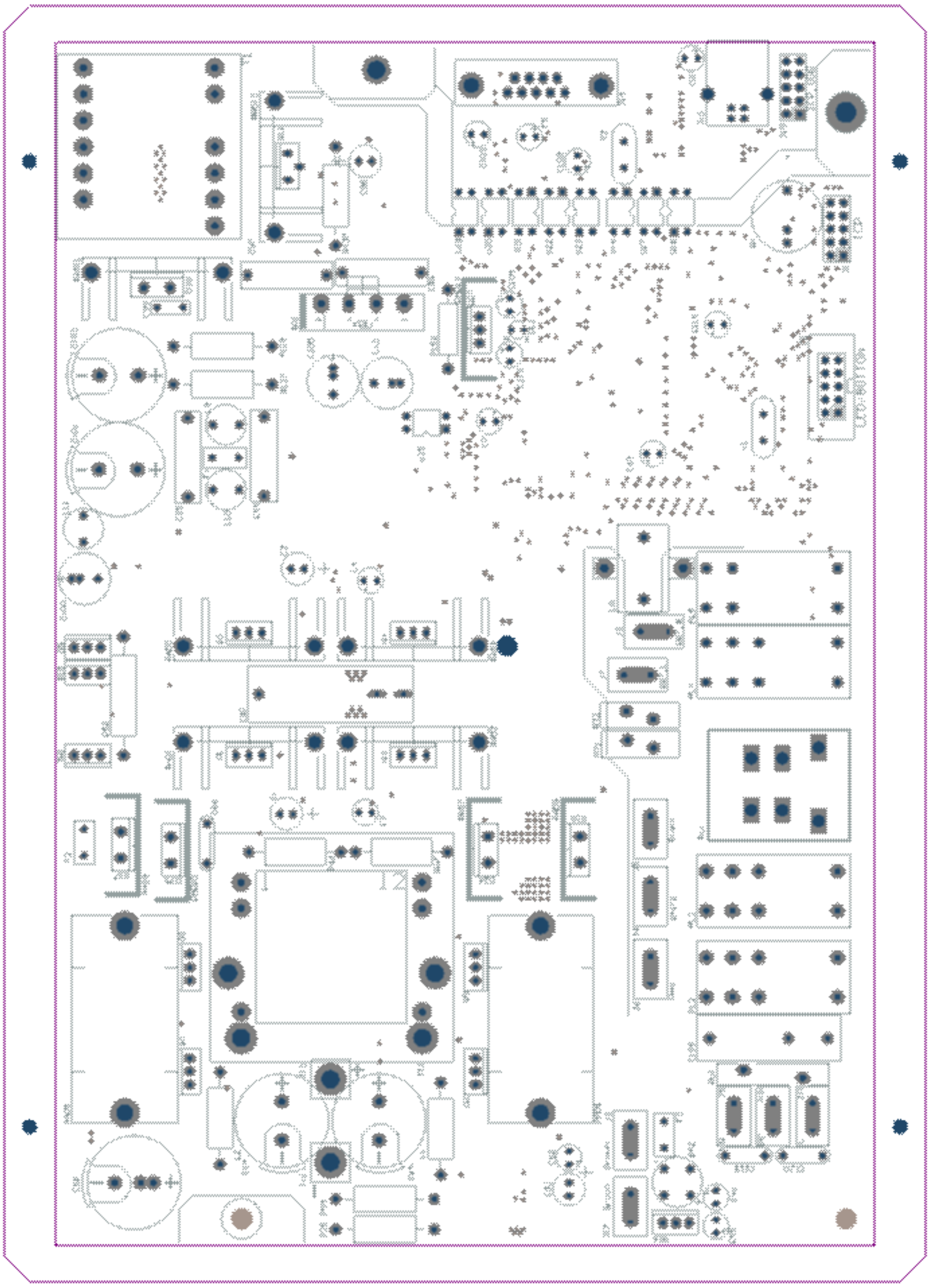
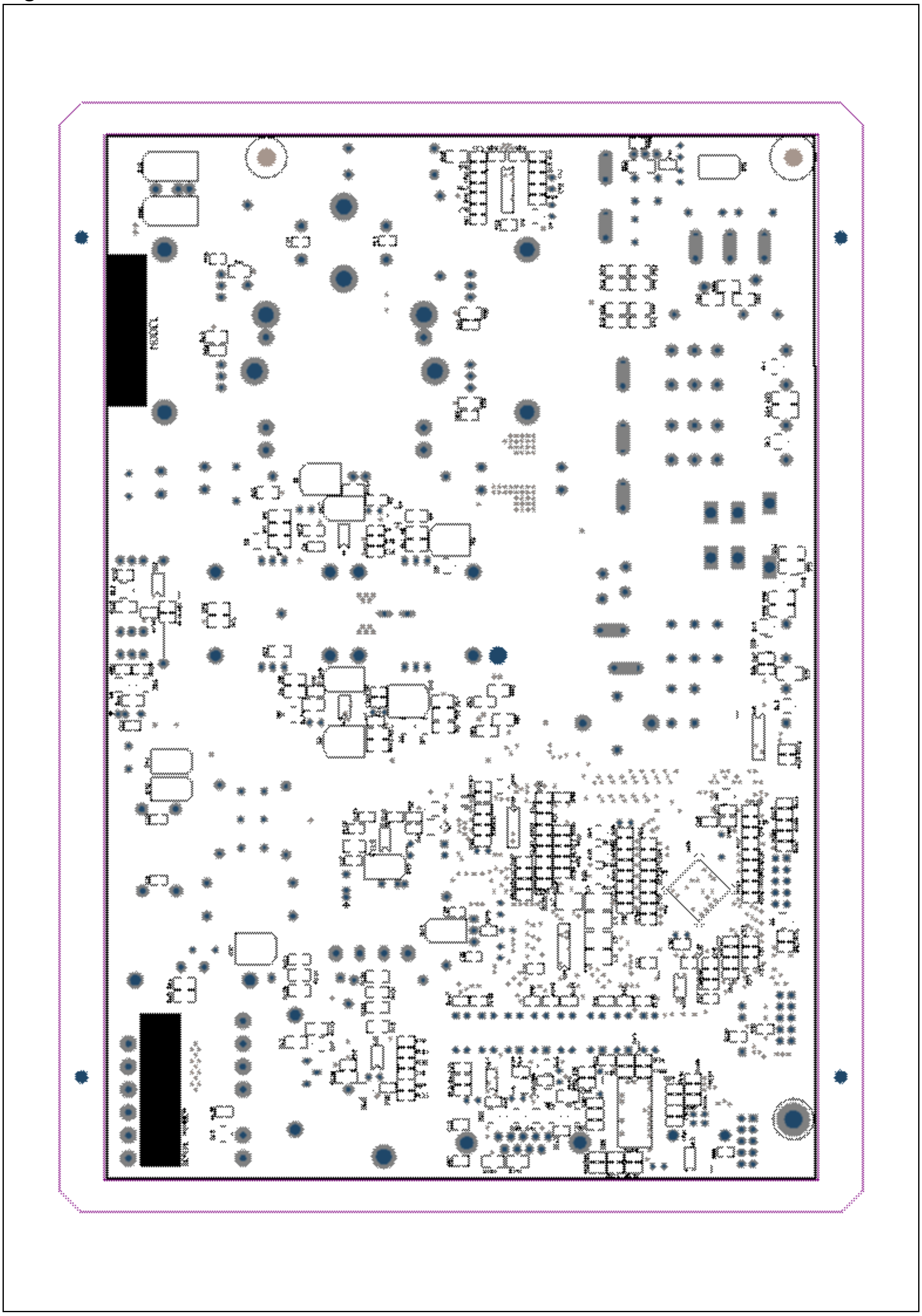


Figure 25. Bottom view



2.3 Assembly description

2.3.1 General

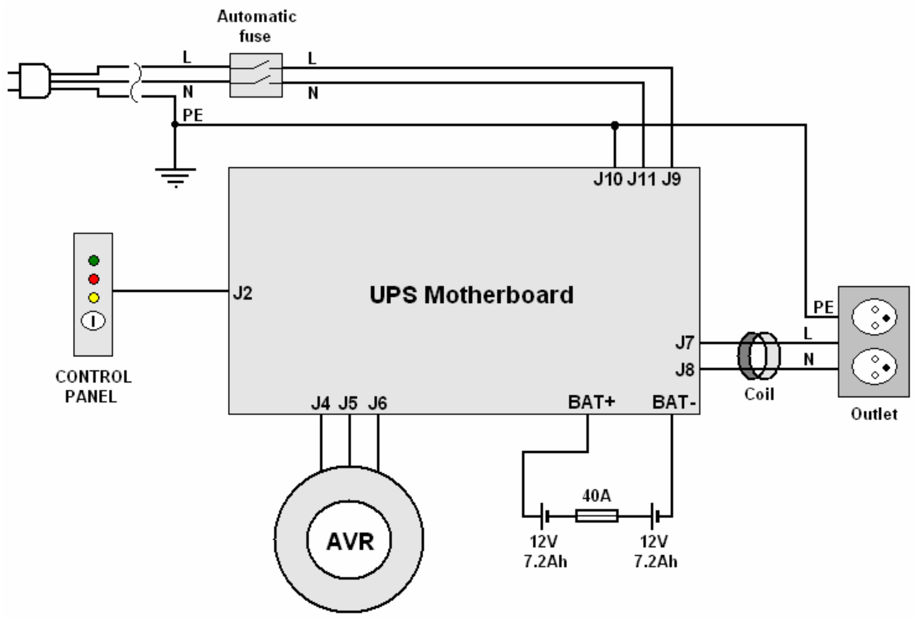
Table 17. UPS components

	Model	
Type	120 Vac version	230 Vac version
Case	UPS Ares 700/1000	
Power cord	3 x 1.0 mm^2	
Control panel	UPS 500 rack	
Battery	VRLA type 2 x 7,2 Ah/12 V	
AVR transformer	AVR 700/ST/120/1	AVR 700/ST/230/1
Switch/fuse	ETA 3120-F35G-P7M1-D04X -12 A	ETA 3120-F35G-P7M1-D04X -6 A
Output wires	Twisted 2x1.0 mm^2, 30 cm long	
Ground wire	1x1.0 mm^2, 30 cm long	
Ferrite toroidal core	Richco RT250-150-120	
Battery fuse	40 A	
Motherboard	ver. 020	

2.3.2 Electrical

The schematic of the electrical connections is shown in *Figure 26*.

Figure 26. Electrical connections



2.3.3 Mechanical

The UPS case with assembled front and power cord.

Figure 27. Mechanical view

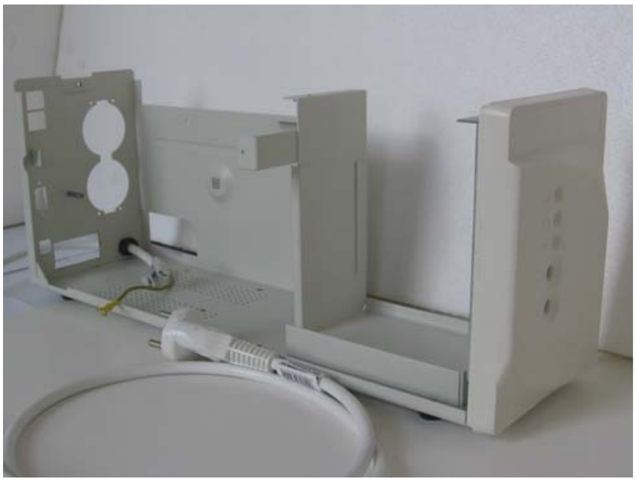


Figure 28. UPS with assembled rear outlets

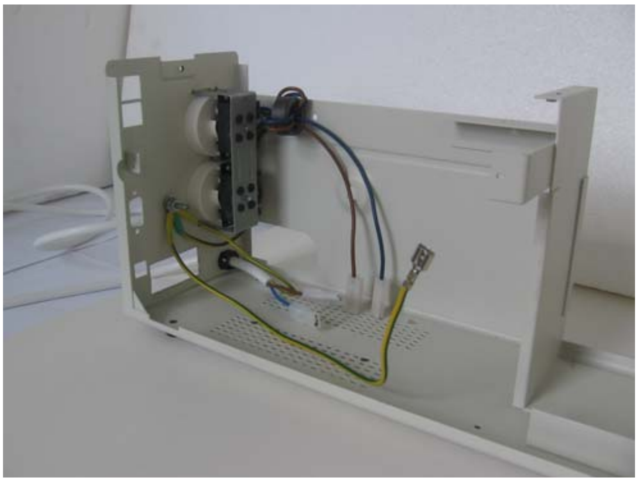


Figure 29. UPS with front button and indicators



Figure 30. UPS with batteries and battery fuse



Figure 31. UPS with battery fuse



Figure 32. UPS with AVR transformer

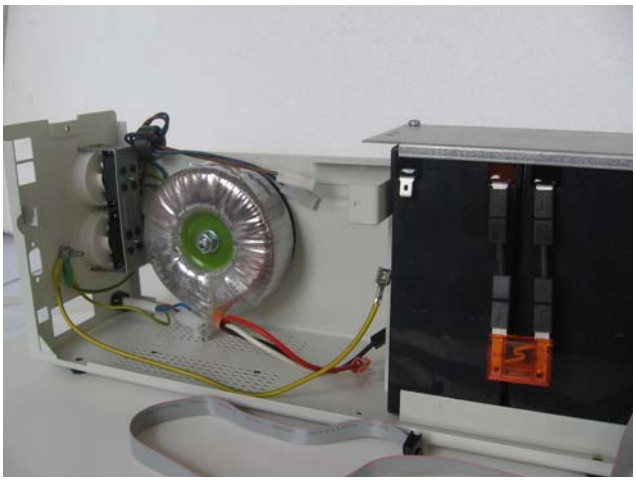


Figure 33. UPS with automatic fuse and power wires

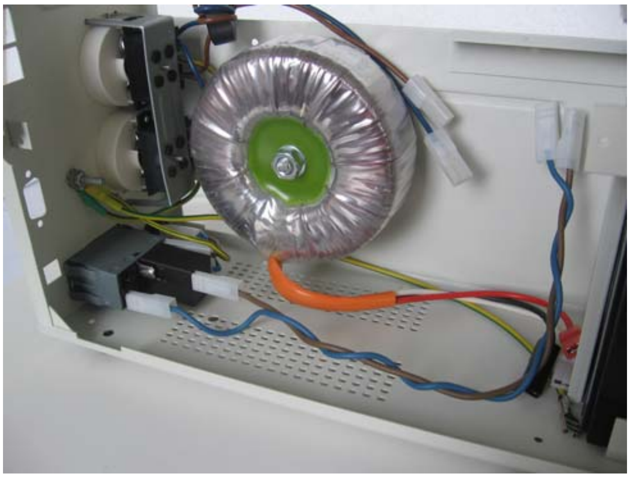


Figure 34. UPS with motherboard



Figure 35. UPS fully assembled



Figure 36. UPS



2.4 Connectors

2.4.1 PCB: mains input

Table 18. PCB: mains input

Connector identification	Type	Description
J9	Tabs	Line in L
J10	Tabs	Line in N
J11	Tabs	PE

2.4.2 PCB: outlet output

Table 19. PCB: outlet output

Connector identification	Type	Description
J7	Tabs	Line out L
J8	Tabs	Line out P

2.4.3 PCB: AVR transformer

Table 20. PCB: AVR transformer

Connector identification	Type	Description
J4	Tabs	Black
J5	Tabs	White
J6	Tabs	Red

Table 20. PCB: AVR transformer (continued)

Connector identification	Type	Description
J3	Tabs	Brown
J17	Tabs	Brown

2.4.4 PCB: battery

Table 21. PCB: battery

Connector identification	Type	Description
-BAT	Solder pad	Battery -
+BAT	Solder pad	Battery +

2.4.5 PCB

Table 22. PCB

Connector identification	Type	Description
J2	IDC10	Control panel

2.4.6 PCB

Table 23. PCB

Connector identification	Type	Description
J1	IDC10	ISP for ST72F324J6T6

2.4.7 PCB

Table 24. PCB

Connector identification	Type	Description
J15	IDC10	ISP for ST72F623F2M1

2.5 Signalization description

2.5.1 Indicators

Table 25. Indicators

	Green LED (mains)	Yellow LED (battery)	Red LED (failure/overload)
Mains mode	Solid on	Off	Off
Battery mode	Off	Solid on Flash On (BATLOW)	Off
Buck/boost mode	Flash on	Off	Off
Battery charging	Solid on	Flash on	Off
Overload (mains)	Solid on	Off	Flash on
Overload (battery)	Off	Solid On	Flash on
Self test	Solid on	Solid on	Off
Fault (mains)	Solid on	Off	Solid on
Fault (battery)	Off	Solid on	Solid on
Standby mode	Off	Off	Flash on (one per 2 sec.)

2.5.2 Sound alarms

Table 26. Sound alarms

State	Beeper alarm sequence
Inverter mode	1 beep with 1 s. interval by 15 s. and after this 1 beep with 15 s. interval
Overload	1 beep with 0.3 s. interval
BATLOW	continuous signal
State	Beeper alarm sequence
Inverter mode	1 beep with 1 s. interval by 15 s. and after this 1 beep with 15 s. interval

2.6 Bill of material

2.6.1 Bill of material for 120 Vac version

Table 27. Bill of material for 120 Vac version

Part type	Designator	Manufacturer	Qty	Ordering code
0.68 R 2 W	R137	Royal Ω	1	MOR I 2W J 68K T 1 0
0 R	R28	Yageo	1	RC 0805 J R-07 0R L

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
0 R	R5,R3	Yageo	2	RC 1206 J R-07 0R L
1,25 A	F1, F3	ESKA	1	RFTQ 1.25A
1.5 kΩ	R141	Yageo	1	RC 0805 J R-07 1K5 L
1.5 nF	C115,C118,C116,C117	Yageo	4	CC0805KRX7R9BB152
1.5 µH / 10 A	L2,L1	Richco	2	RI-RRH50-15-110
1:1000	L8	DTW	1	1000CT1307C
1 M	R162	Yageo	1	RC 0805 J R-07 1M L
1 kΩ 3 W	R35,R34	Royal Ω	2	MOR I 3W J 102 T 1 0
1 kΩ	R154,R38,R37,R26,R155	Yageo	5	RC 0805 J R-07 1K L
1 nF 1 kV	C86	Vishay	1	1DF0D10
1 nF 500 V	C99	Vishay	1	1DF0D10
1 nF	C38,C34,C49,C73,C43,C37	Yageo	6	CC 0805 M R X7R 9 B B 102
1 µF 400 V	C87	EVOX Rifa	1	PHE426KF7100J
1 µF / 50 V	C110	Kemet	1	C06(4)(1)105K5X5C(2)
2.2 kΩ	R119,R175,R118,R121,R120	Yageo	5	RC 0805 J R-07 2K2 L
2.2 µF/50 V	C109	Yageo	1	SH050M2R20A5F-0511
2.4 kΩ	R148	Yageo	1	RC 0805J R-07 2K4 L
2 kΩ	R176,R49,R161	Yageo	3	RC 0805 F R-07 2K L
3,15 A 250 V	F2	ESKA	1	RFTQ 3.15A
3.3 kΩ	R115,R114,R116,R36,R113	Yageo	5	RC 0805 J R-07 3K3 L
3.3 kΩ	R142	Yageo	1	RC 1206 J R-07 3K3 L
4,7 nF	C120,C119	Vishay	2	VY2472M49Y5US6*V7
4.3 kΩ	R144,R143	Yageo	2	RC 0805 J R-07 4K3 L
4.7 R 3 W	R52	Royal Ω	1	MOR I 3W J 47J T 1 0
4.7 kΩ	R48,R110,R39,R43,R41,R42, R46,R86,R45,R40,R47,R44,R50, R51	Yageo	14	RC 0805 J R-07 4K7 L
4.7 kΩ	R145,R146	Yageo	2	RC 1206 J R-07 4K7 L
4.7 nF	C33	Yageo	1	CC 0805 M R X7R 9 B B 473
4.7 µH	L4,L7,L3,L5,L6	Vishay	5	IMC1210-4.7
5.6 kΩ	R30	Yageo	1	RC 0805 F R-07 5K6 L
5.6 kΩ	R139	Yageo	1	RC 1206 J R-07 5K6 L
6.3x0.8	J8,J10,J7,J5,J4,J9,J11,J6,J3,J17	Zierick	10	836/836-Tape
6.8 kΩ	R150,R149,R29,R151	Yageo	4	RC 0805 F R-07 6K8 L

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
7.5 kΩ	R18	Yageo	1	RC 0805 J R-07 7K5 L
10 R	R129,R158	Yageo	2	RC 0805 J R-07 10R L
10 R	R64,R61,R60,R62,R59,R63,R65, R164,R172	Yageo	9	RC 1206 J R-07 10R L
10 kΩ	R91,R97,R87,R117,R95,R170,R 171,R94,R27,R102,R101,R100,R 103,R166,R92,R96,R165,R98, R169,R93,R168,R167	Yageo	22	RC 0805 J R-07 10K L
10 kΩ	R11,R12,R16,R15,R14,R13	Yageo	6	RC 1206 J R-07 10K L
10 nF	C80,C79,C76,C85,C68,C81,C67, C77,C84,C83,C70,C71,C74	Yageo	13	CC 0805 M K X7R 9 B N 103
10 µF/25 V	C2,C1	Yageo	2	SB025M0010A5F-0611
10 µF/35 V	C3,C4,C7,C6,C5	Yageo	5	SH035M0010A5F-0511
10 µF/50 V	C63,C62	Yageo	2	SH050M0010A5F-0511
10 µF/100 V	C45	Yageo	1	SH035M0010A5F-0511
12 MHz	Y2	CQ	1	12.00M HC49-S
12 V	ZD3	Fairchild	1	BZX84C12
16 MHz	Y1	CQ	1	16.00M HC49-S
16 kΩ	R134	Yageo	1	RC 0805 J R-07 16K L
20 kΩ	R159	Yageo	1	RC 0805 F R-07 20K L
22 R 1 W	R152	Royal Ω	1	MOR I 1W J 220 T 1 0
22 kΩ	R23,R57,R24,R58,R55,R56,R54, R53	Yageo	8	RC 0805 F R-07 22K L
22 nF	C112	Yageo	1	CC 0805 M K Y5V 9 B N 223
22 pF	C91,C90,C88,C89,C92	Yageo	5	CC0805MKX7R9BN220
22 µF/35 V	C103,C104	Yageo	2	SH035M0022A5F-0511
10 µH/3 A	L10,L11,L9	Feryster	3	DSz-8/10/3-V
30 kΩ	R31	Yageo	1	RC 0805 F R-07 30k L
33 R	R17	Yageo	1	RC 0805 J R-07 33R L
33 R	R133	Yageo	1	RC 1206 J R-07 33R L
33 kΩ	R99,R138, R96	Yageo	3	RC 0805 J R-07 33K L
36 kΩ	R153	Yageo	1	RC 1206 J R - 07 36K L
39 kΩ	R136	Yageo	1	RC 0805 J R-07 39K L
43 kΩ	R135	Yageo	1	RC 0805 J R-07 43K L
47.5 kΩ	R157,R156	Yageo	2	RC 0805 F R-07 47K5 L
47 R	R33	Yageo	1	RC 0805 J R-07 47R L

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
47 R	R173,R174	Yageo	2	RC 1206 J R-07 47R L
47 nF X2	C95	Arcotronics	1	MKPX2-47NR15
47 µF/25 V	C113,C114, C46	Yageo	2	SH025M0047A5F-0511
47 µF/50 V	C98	Yageo	1	SC050M0047A5F-0611
51 R	R6,R4	Yageo	2	RC 1206 J R-07 51R L
82 kΩ	R160	Yageo	1	RC 0805 F R-07 82K L
100 R	R111,R112	Yageo	2	RC 0805 J R-07 100R L
100 R	R2,R8,R1,R9,R10,R7	Yageo	6	RC1206JR-07100RL
100 kΩ	R122,R21,R20,R25,R22,R32, R19	Yageo	7	RC 0805 J R-07 100K L
100 kΩ	R123,R68,R126,R71,R69,R70,R124,R125,R80,R72,R73,R83,R81,R82,R75,R74	Yageo	16	RC 1206 J R-07 100K L
100 nF	C20,C19,C12,C14,C15,C13,C11,C18,C21,C30,C29,C28,C8,C72,C23,C25,C16,C17,C24,C22,C9,C10,C26,C48,C27,C31,C41	Yageo	27	CC 0805 K R X7R 9 B B 104
100 nF X2	C96	Arcotronics	1	MKPY2-100NR15
100 pF	C50,C57,C58,C54,C55,C53,C51,C52,C56,C35,C36,C39,C61,C40,C59,C60	Yageo	16	CC 0805 M R X7R 9 B B 101
100 µF/25 V	C32	Yageo	1	SH050M0010A5F-0611
100 µF/35 V	C105	Yageo	1	SC035M0100A5F-0811
100 µF/50 V	C100	Yageo	1	SC050M0100A5F-0815
120 k 3 W	R128,R127	Royal Ω	2	MOR I 3W J 124 T 1 0
180 R	R140	Yageo	1	RC 0805 J R-07 180R L
200 kΩ	R88,R89,R90	Yageo	3	RC 1206 F R-07 200K L
330 R 2 W	R67,R66	Royal Ω	2	MOR I 2W J 331 T 1 0
330 R	R107,R106,R108,R105,R109, R104	Yageo	6	RC 0805 J R-07 330R L
330 µH / 0.5 A	L12	Feryster	1	DSz-9/330/0,9-V
360 kΩ	R78,R76,R77,R79	Yageo	4	RC 1206 F R-07 360K L
470 nF	C106	Yageo	1	CC 0805 M K X7R 9 B N 474
470 nF	C108	Arcotronics	1	MKPX2-470NR22
470 µF/63 V	C66	Rubycon	1	63 YXG 470 M CA 16X20
680 pF 1600 V	C97	WIMA	1	FKP1 680/1600
750 kΩ	R131,R130,R132	Yageo	3	RC 1206 J R-07 750K L

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
820 R	R147	Yageo	1	RC 0805 J R-07 820R L
1000 µF/50 V	C101,C102	Rubycon	2	50 YXG 1000 M CA 16X25
3300 µF/35 V	C65,C64	Yageo	2	SC035M3300A5F-1836
BAS16	D15,D5,D6,D22,D7,D24,D21,D19,D14,D11,D23,D18,D13,D3,D20,D9,D4,D17,D16,D12,D10,D8	Fairchild	22	BAS16
BAT54	D46	Vishay	1	BAT54-GS18
BAT54A	D41	Vishay	1	BAT54A-GS18
BAT54C	D39	Vishay	1	BAT54C-GS18
BAT54S	D40	Vishay	1	BAT54S-GS18
BC846B	Q13	Infineon technologies	1	BC846B
BC857B	Q12,Q14	Fairchild	2	BC857B
BDX53C	Q16	STMicroelectronics	1	BDX53C
BPT-14	B1	Bestar electronics industry	1	BPT-14
B600C1500	BR2	DC Components	1	B600C1500
BZV55C10	D32,D31	Central semiconductor, Microsemi	2	BZV55C10
BZV55C20	D34,D33	Central semiconductor, Microsemi	2	BZV55C20
BZV55C20	D35	Central semiconductor, Microsemi	1	BZV55C20
BZV55C22	D50	Central semiconductor, Microsemi	1	BZV55C22
BZV55C75	D49,D36	Central semiconductor, Microsemi	2	BZV55C75
Heatsink	RAD5,RAD6	Fideltronik	2	40X53X20 (MUP831)
Heatsink	RAD13,RAD10,RAD9,RAD7,RAD8	Fideltronik	5	LM-317 (MUPS190)
Heatsink	RAD12,RAD4,RAD1,RAD3,RAD11,RAD2	Fischer elektronik	6	SK145 37,5 STS TO220
IDC10	J15,J1	Molex	2	MX-5332-10GS1
IDC10	J2	Molex	1	MX-5332-10GS1
JNR15S2R5M	RT1,RT2	Joyin	2	JNR15S2R5M

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
JVR-20N271K	RV1	Joyin	1	JVR-20N271K
KBU605	BR1	Taiwan semiconductor	1	70-070-65 Elfa
L5970D	U26	ST	1	L5970D013TR
L6387D	U1,U2	STMicroelectronics	2	L6387D
L6565	U11	STMicroelectronics	1	L6565D
LD1086V50	U27	STMicroelectronics	1	LD1086V50
LED	DL1	Kingbrigth	1	L-934LSRD
LM324	U28	STMicroelectronics	1	LM324D
M74HC4053RM13TR	U24	STMicroelectronics	1	M74HC4053RM13TR
M95020MN6P	U10	STMicroelectronics	1	M95020MN6P
MMBTA42	Q15	STMicroelectronics	1	MMBTA42
PC817C	U17,U23,U16,U18,U19,U21,U22, U20	Sharp	8	PC817C
PDTC114ET	U7,U6,U4	Philips	3	PDTC114ET
RM84-2012-25-1024	RL4	Relpol	1	RM84-2012-25-1024
RM84-2022-25-1024	RL5	Relpol	1	RM84-2022-25-1024
RM85-2011-25-1024	RL2,RL3	Relpol	2	RM85-2011-25-1024
SCL-1-H-DPNO	RL1	Song Chuan	1	SCL-1-H-DPNO (24V coil voltage)
SFH620A-2	U25	Vishay	1	SFH620A-2
SG3525A	U3	STMicroelectronics	1	SG3525AP
SM6T18A	ZD2,ZD1	STMicroelectronics	2	SM6T18A
SMBYT01	D2,D1	STMicroelectronics	2	SMBYT01
ST72F324J6T6	U29	STMicroelectronics	1	ST72F324J6T6
ST72F623F2M1	U15	STMicroelectronics	1	ST72F623F2M1
STM809L	U8	STMicroelectronics	1	STM809LWX6F
STP5NK90Z	Q11	STMicroelectronics	1	STP5NK90Z
STP22NS25Z	Q3,Q4,Q1,Q2	STMicroelectronics	4	STP22NS25Z
STP75NF75	Q8,Q6,Q5,Q7	STMicroelectronics	4	STP75NF75
STP80PF55	Q10,Q9	STMicroelectronics	2	STP80PF55
STPS1L60A	D45	STMicroelectronics	1	STPS1L60A
STPS8H100D	D38	STMicroelectronics	1	STPS8H100D
STTA106	D37	STMicroelectronics	1	STTA106U
STTH1L06A	D48,D47	STMicroelectronics	2	STTH1L06A
STTH102A	D43,D42,D44, D51	STMicroelectronics	4	STTH102A

Table 27. Bill of material for 120 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
STTH302S	D30,D29	STMicroelectronics	2	STTH302S
STTH803D	D28,D25,D26,D27	STMicroelectronics	4	STTH803D
TI50/30v01	T1	Sigma	1	TI50/30v01
TI700/24/2v01	TI1	Sigma	1	TI700/24/2v01
TL431CD	U12	Fairchild	1	TL431CD
TS555CDT	U14	STMicroelectronics	1	TS555CDT
TYN608	TH1	STMicroelectronics	1	TYN608RG
ULN2003D	U9	STMicroelectronics	1	ULN2003D
USB6B1	U13	STMicroelectronics	1	USB6B1RL
USB-B	J13	JST	1	UBB-4R-D10T-1

2.6.2 Bill of material for 230 Vac version

Table 28. Bill of material for 230 Vac version

Part type	Designator	Manufacturer	Qty	Ordering code
0.68 R 2 W	R137	Royal Ω	1	MOR I 2W J 68K T 1 0
0 R	R28	Yageo	1	RC 0805 J R-07 0R L
0 R	R3,R5	Yageo	2	RC 1206 J R-07 0R L
1,25 A	F1, F3	ESKA	1	RFTQ 1.25A
1.5 kΩ	R141	Yageo	1	RC 0805 J R-07 1K5 L
1.5 nF	C117,C116,C115,C118	Yageo	4	CC0805KRX7R9BB152
1.5 µH / 10 A	L2,L1	Richco	2	RI-RRH50-15-110
1:1000	L8	DTW	1	1000CT1307C
1 M	R162	Yageo	1	RC 0805 J R-07 1M L
1 kΩ 3 W	R34,R35	Royal Ω	2	MOR I 3W J 102 T 1 0
1 kΩ	R26,R155,R38,R37,R154	Yageo	5	RC 0805 J R-07 1K L
1 nF 1 kV	C86	Vishay	1	1DF0D10
1 nF 500 V	C99	Vishay	1	1DF0D10
1 nF	C43,C37,C49,C38,C34,C73	Yageo	6	CC 0805 M R X7R 9 B B 102
1 µF / 50 V	C110	Kemet	1	C06(4)(1)105K5X5C(2)
2.2 kΩ	R119,R118,R120,R175,R121	Yageo	5	RC 0805 J R-07 2K2 L
2.2 µF/50 V	C109	Yageo	1	SH050M2R20A5F-0511
2.4 kΩ	R148,R161	Yageo	2	RC 0805J R-07 2K4 L
2 kΩ	R49,R176	Yageo	2	RC 0805 F R-07 2K L

Table 28. Bill of material for 230 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
3,15 A 250 V	F2	ESKA	1	RFTQ 3.15A
3.3 kΩ	R115,R116,R114,R36,R113	Yageo	5	RC 0805 J R-07 3K3 L
3.3 kΩ	R142	Yageo	1	RC 1206 J R-07 3K3 L
4,7 nF	C119,C120	Vishay	2	VY2472M49Y5US6*V7
4.3 kΩ	R143,R144	Yageo	2	RC 0805 J R-07 4K3 L
4.7 R 3 W	R52	Royal Ω	1	MOR I 3W J 47J T 1 0
4.7 kΩ	R48,R40,R41,R86,R110,R45, R43,R47,R44,R39,R46,R42,R51, R50	Yageo	14	RC 0805 J R-07 4K7 L
4.7 kΩ	R145,R146	Yageo	2	RC 1206 J R-07 4K7 L
4.7 nF	C33	Yageo	1	CC 0805 M R X7R 9 B B 473
4.7 µH	L7,L4,L3,L6,L5	Vishay	5	IMC1210-4.7
5.6 kΩ	R30	Yageo	1	RC 0805 F R-07 5K6 L
5.6 kΩ	R139	Yageo	1	RC 1206 J R-07 5K6 L
6.3x0.8	J8,J10,J7,J5,J4,J9,J11,J6, J3, J17	Zierick	10	836/836-Tape
6.8 kΩ	R149,R151,R29,R150	Yageo	4	RC 0805 J R-07 6K8 L
7.5 kΩ	R18	Yageo	1	RC 0805 J R-07 7K5 L
10 R	R129	Yageo	1	RC 0805 J R-07 10R L
10 R	R172,R60,R63,R164,R59,R62, R64,R61,R65	Yageo	9	RC 1206 J R-07 10R L
10 kΩ	R166,R171,R91,R117,R102, R103,R169,R167,R93,R168, R170,R165,R98,R95,R87,R96, R100,R92,R97,R27,R94,R101	Yageo	22	RC 0805 J R-07 10K L
10 kΩ	R16,R12,R13,R15,R11,R14	Yageo	6	RC 1206 J R-07 10K L
10 nF	C79,C76,C77,C74,C70,C71,C67, C85,C81,C84,C83,C68,C80	Yageo	13	CC 0805 M R X7R 9 B B 103
10 µF/25 V	C2,C1	Yageo	2	SB025M0010A5F-0611
10 µF/35 V	C4,C6,C3,C7,C5	Yageo	5	SH035M0010A5F-0511
10 µF/50 V	C62,C63	Yageo	2	SC050M0010A5F-0511
10 µF/100 V	C45	Yageo	1	SH035M0010A5F-0511
10 µH/3 A	L10,L11,L9	Feryster	3	DSz-8/10/3-V
12 MHz	Y2	CQ	1	12.00M HC49-S
16 MHz	Y1	CQ	1	16.00M HC49-S
16 kΩ	R134	Yageo	1	RC 0805 J R-07 16K L
20 R	R158	Yageo	1	RC 0805 F R-07 20R L

Table 28. Bill of material for 230 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
20 kΩ	R159	Yageo	1	RC 0805 F R-07 20K L
22 R 1 W	R152	Royal Ω	1	MOR I 1W J 220 T 1 0
22 kΩ	R24,R55,R53,R57,R56,R58,R54, R23	Yageo	8	RC 0805 F R-07 22K L
22 nF	C112	Yageo	1	CC 0805 M K Y5V 9 B N 223
22 pF	C90,C92,C91,C89,C88	Yageo	5	CC0805MKX7R9BN220
22 µF/35 V	C104,C103	Yageo	2	SH035M0022A5F-0511
33 R	R17	Yageo	1	RC 0805 J R-07 33R L
33 R	R133	Yageo	1	RC 1206 J R-07 33R L
33 kΩ	R138,R99, R96	Yageo	3	RC 0805 J R-07 33K L
36 kΩ	R153,R31	Yageo	2	RC 1206 J R - 07 36K L
39 kΩ	R136	Yageo	1	RC 0805 J R-07 39K L
43 kΩ	R135	Yageo	1	RC 0805 J R-07 43K L
47.5 kΩ	R156,R157	Yageo	2	RC 0805 F R-07 47K5 L
47 R	R33	Yageo	1	RC 0805 J R-07 47R L
47 R	R173,R174	Yageo	2	RC 1206 J R-07 47R L
47 nF X2	C95	Arcotronics	1	MKPX2-47NR15
47 µF/25 V	C114,C113, C46	Yageo	3	SH025M0047A5F-0511
47 µF/50 V	C98	Yageo	1	SC050M0047A5F-0611
51 R	R4,R6	Yageo	2	RC 1206 J R-07 51R L
82 kΩ	R160	Yageo	1	RC 0805 F R-07 82K L
100 R	R112,R111	Yageo	2	RC 0805 J R-07 100R L
100 R	R7,R1,R2,R8,R9,R10	Yageo	6	RC 1206 J R-07 100R L
100 kΩ	R20,R25,R21,R122,R22,R19	Yageo	6	RC 0805 J R-07 100K L
100 kΩ	R123,R125,R126,R124	Yageo	4	RC 1206 J R-07 100K L
100 nF	C26,C18,C30,C29,C48,C21,C25, C28,C27,C24,C22,C23,C20,C11, C12,C15,C16,C13,C19,C17,C72, C14,C31,C9,C10,C8, C41	Yageo	27	CC 0805 M K X7R 9 B N 104
100 nF X2	C96	Arcotronics	1	MKPY2-100NR15
100 pF	C40,C52,C61,C35,C51,C59,C39, C60,C55,C57,C50,C56,C54,C36, C58,C53	Yageo	16	CC 0805 M K X7R 9 B N 101
100 µF/25 V	C32	Yageo	1	SH050M0010A5F-0611
100 µF/35 V	C105	Yageo	1	SC035M0100A5F-0811
100 µF/50 V	C100	Yageo	1	SC050M0100A5F-0815

Table 28. Bill of material for 230 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
120 kΩ 3 W	R128,R127	Royal Ω	2	MOR I 3W J 124 T 1 0
180 R	R140	Yageo	1	RC 0805 J R-07 180R L
200 kΩ	R82,R83,R89,R80,R90,R81,R88,R70,R72,R68,R69,R73,R71,R75,R74	Yageo	15	RC 1206 F R-07 200K L
330 R 2 W	R66,R67	Royal Ω	2	MOR I 2W J 331 T 1 0
330 R	R108,R104,R106,R105,R109,R107	Yageo	6	RC 0805 J R-07 330R L
330 nF	C87	EVOX Rifa	1	PHE426MD6330J
330 µH / 0.9 A	L12	Feryster	1	DSz-9/330/0,9-V
390 kΩ	R32	Yageo	1	RC 0805 F R-07 390K L
470 nF	C106	Yageo	1	CC 0805 M K X7R 9 B N 474
470 nF	C108	Arcotronics	1	MKPX2-470NR22
470 µF/63 V	C66	Rubycon	1	63 YXG 470 M CA 16X20
680 pF 1600 V	C97	WIMA	1	FKP1 680/1600
750 kΩ	R78,R76,R79,R77,R130,R131,R132	Yageo	7	RC 1206 F R-07 750K L
820 R	R147	Yageo	1	RC 0805 J R-07 820R L
1000 µF/50 V	C101,C102	Rubycon	2	50 YXG 1000 M CA 16X25
3300 µF/35 V	C64,C65	Yageo	2	SC035M3300A5F-1836
BAS16	D15,D7,D16,D6,D4,D17,D11,D18,D23,D24,D20,D14,D13,D10,D19,D5,D22,D9,D12,D3,D8,D21	Fairchild	22	BAS16
BAT54	D46	Vishay	1	BAT54-GS18
BAT54A	D41	Vishay	1	BAT54A-GS18
BAT54C	D39	Vishay	1	BAT54C-GS18
BAT54S	D40	Vishay	1	BAT54S-GS18
BC846B	Q13	Infineon technologies	1	BC846B
BC857B	Q12,Q14	Fairchild	2	BC857B
BDX53C	Q16	STMicroelectronics	1	BDX53C
BPT-14	B1	Bestar electronics industry	1	BPT-14
B600C1500	BR2	DC Components	1	B600C1500
BZV55C10	D32,D31	Central semiconductor , microsemi	2	BZV55C10

Table 28. Bill of material for 230 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
BZV55C20	D35	Central semiconductor, microsemi	1	BZV55C20
BZV55C20	D34,D33	Central semiconductor, microsemi	2	BZV55C20
BZV55C22	D50	Central semiconductor, microsemi	1	BZV55C22
BZV55C75	D36,D49	Central semiconductor, microsemi	2	BZV55C75
BZX84C12	ZD3	Fairchild	1	BZX84C12
Heatsink	RAD5,RAD6	Fideltronik	2	40X53X20 (MUP831)
Heatsink	RAD10,RAD9,RAD13,RAD8,RAD7	Fideltronik	5	LM-317 (MUPS190)
Heatsink	RAD11,RAD3,RAD1,RAD4,RAD2,RAD12	Fischer Elektronik	6	SK145 37,5 STS TO220
IDC10	J1,J15	Molex	2	MX-5332-10GS1
IDC10	J2	Molex	1	MX-5332-10GS1
JNR15S70L	RT1,RT2	Joyin	2	JNR15S70L
JVR-20N471K	RV1	Joyin	1	JVR-20N471K
KBU605	BR1	Taiwan Semiconductor	1	KBU605
L5970D	U26	STMicroelectronics	1	L5970D013TR
L6387D	U1,U2	STMicroelectronics	2	L6387D
L6565	U11	STMicroelectronics	1	L6565D
LD1086V50	U27	STMicroelectronics	1	LD1086V50
LED	DL1	Kingbrigth	1	L-934LSRD
LM324	U28	STMicroelectronics	1	LM324D
M74HC4053RM13TR	U24	STMicroelectronics	1	M74HC4053RM13TR
M95020MN6P	U10	STMicroelectronics	1	M95020MN6P
MMBTA42	Q15	STMicroelectronics	1	MMBTA42
PC817C	U21,U18,U16,U19,U22,U17,U20,U23	Sharp	8	PC817C
PDTC114ET	U6,U4,U7	Philips	3	PDTC114ET
RM84-2012-25-1024	RL4	Relpol	1	RM84-2012-25-1024
RM84-2022-25-1024	RL5	Relpol	1	RM84-2022-25-1024
RM85-2011-25-1024	RL2,RL3	Relpol	2	RM85-2011-25-1024

Table 28. Bill of material for 230 Vac version (continued)

Part type	Designator	Manufacturer	Qty	Ordering code
SCL-1-H-DPNO	RL1	Song Chuan	1	SCL-1-H-DPNO 24V
SFH620A-2	U25	Vishay	1	SFH620A-2
SG3525A	U3	STMicroelectronics	1	SG3525AP
SM6T18A	ZD1,ZD2	STMicroelectronics	2	SM6T18A
SMBYT01	D2,D1	STMicroelectronics	2	SMBYT01
ST72F324J6T6	U29	STMicroelectronics	1	ST72F324J6T6
ST72F623F2M1	U15	STMicroelectronics	1	ST72F623F2M1
STM809L	U8	STMicroelectronics	1	STM809LWX6F
STP5NK90Z	Q11	STMicroelectronics	1	STP5NK90Z
STP12NM50	Q1,Q2,Q4,Q3	STMicroelectronics	4	STP12NM50
STP75NF75	Q6,Q5,Q8,Q7	STMicroelectronics	4	STP75NF75
STP80PF55	Q10,Q9	STMicroelectronics	2	STP80PF55
STPS1L60A	D45	STMicroelectronics	1	STPS1L60A
STPS8H100D	D38	STMicroelectronics	1	STPS8H100D
STTA106	D37	STMicroelectronics	1	STTA106U
STTH1L06A	D48,D47	STMicroelectronics	2	STTH1L06A
STTH8R06D	D27,D26,D25,D28	STMicroelectronics	4	STTH8R06D
STTH102A	D43,D42,D44, D51	STMicroelectronics	4	STTH102A
STTH302S	D29,D30	STMicroelectronics	2	STTH302S
TI50/30v01	T1	Sigma	1	TI50/30v01
TI700/24/1v01	TI1	Sigma	1	TI700/24/1/v01
TL431CD	U12	Fairchild	1	TL431CD
TS555CDT	U14	STMicroelectronics	1	TS555CDT
TYN608	TH1	STMicroelectronics	1	TYN608RG
ULN2003D	U9	STMicroelectronics	1	ULN2003D
USB6B1	U13	STMicroelectronics	1	USB6B1RL
USB-B	J13	JST	1	UBB-4R-D10T-1

3 Technical specifications

Table 29. Technical specifications

Parameters	120 V/60 Hz model	230 V/50 Hz model
Output rating power	700 VA/450 W	700 VA/450 W
Input voltage	83 Vac±3% - 153 Vac±3%	160 Vac±3% - 294 Vac±3%
Input frequency	60 Hz	50 Hz
Power factor	0.6 lagging at 700 VA	0.6 lagging at 700 VA
Operating modes input voltage		
Mains mode	96 – 138 Vac±3 Vac	184 - 265 Vac±3 Vac
Boost mode	83 – 100 Vac ± 3 Vac	160 - 191 Vac ± 3 Vac
Buck mode	134 - 153 Vac±3 Vac	257 - 294 Vac±3 Vac
Inverter mode	0 - 87 Vac±3 Vac 153 - 175 Vac±3 Vac	0 -167 Vac±3 Vac 286-300 Vac±3 Vac
Output voltage		
Mains mode	96 – 138Vac±3Vac	184 - 265 Vac ± 3 Vac
Boost mode	96 – 115Vac±3Vac	184 - 220 Vac ± 3 Vac
Buck mode	117 - 133Vac±3Vac	224 - 256 Vac ± 3 Vac
Inverter mode Battery voltage 28 – 20 Vdc±0.4 Vdc	120Vac +5/-10%	230 Vac +5/-10%
Output frequency	60Hz±0.1Hz	50 Hz ± 0.1Hz
Transfer time	class 3 [EN62040-3]	class 3 [EN62040-3]
Typical	4 ms	4 ms
Maximum	10 ms	10 ms
Inverter output waveform	Quasi-sine (square wave)	Quasi-sine (square wave)
Inverter output waveform THD	70%	70%
Backup time (full load)	2.5 – 3 min	2.5 - 3 min
Battery 2 pcs.		
Type	Maintenance free Lead Acid	Maintenance free Lead Acid
Nominal voltage	12 V	12 V
Capacity	7.2 Ah	7.2 Ah
Recharge time (after full discharge)	max 8 h for 90% recharge max 4 h for 80% recharge	max 8h for 90% recharge max 4h for 80% recharge
BATLOW level	22 – 21.5 Vdc	22 – 21.5Vdc
Battery protection level (UPS output shutdown)	18 – 19 Vdc for load >100 W 20 – 21 Vdc for load <100 W	18 – 19 Vdc for load >100 W 20 – 21 Vdc for load <100 W

Table 29. Technical specifications (continued)

Parameters	120 V/60 Hz model	230 V/50 Hz model
Battery recharge	Two recharge steps	Two recharge steps
First step	Constant current (Imax=2.16 A, Vmax=28.2 Vdc)	Constant current (Imax=2.16 A, Vmax=28.2 Vdc)
Second step	Hysteresis constant voltage V=27.3 Vdc ± 0.5 Vdc	Hysteresis constant voltage V=27.3 Vdc ± 0.5 Vdc

4 Revision history

Table 30. Document revision history

Date	Revision	Changes
18-Jul-2008	1	Initial release

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

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